University of Alberta

Social and Psychological Factors in the Etiology of Disease

by

Susan G. Shaw ©

A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfilment
of the requirements for the degree of Doctor of Philosophy

Department of Sociology

Edmonton, Alberta
Fall, 2004

Library and
Archives Canada

Published Heritage
Branch

395 Wellington Street
Ottawa ON K1A 0N4
Canada

Bibliothèque et
Archives Canada

Direction du
Patrimoine de l'édition

395, rue Wellington
Ottawa ON K1A 0N4
Canada

Your file Votre référence
ISBN: 0-612-96017-X
Our file Notre référence
ISBN: 0-612-96017-X

The author has granted a non-exclusive license allowing the Library and Archives Canada to reproduce, loan, distribute or sell copies of this thesis in microform, paper or electronic formats.

L'auteur a accordé une licence non exclusive permettant à la Bibliothèque et Archives Canada de reproduire, prêter, distribuer ou vendre des copies de cette thèse sous la forme de microfiche/film, de reproduction sur papier ou sur format électronique.

The author retains ownership of the copyright in this thesis. Neither the thesis nor substantial extracts from it may be printed or otherwise reproduced without the author's permission.

L'auteur conserve la propriété du droit d'auteur qui protège cette thèse. Ni la thèse ni des extraits substantiels de celle-ci ne doivent être imprimés ou aturement reproduits sans son autorisation.

In compliance with the Canadian Privacy Act some supporting forms may have been removed from this thesis.

Conformément à la loi canadienne sur la protection de la vie privée, quelques formulaires secondaires ont été enlevés de cette thèse.

While these forms may be included in the document page count, their removal does not represent any loss of content from the thesis.

Bien que ces formulaires aient inclus dans la pagination, il n'y aura aucun contenu manquant.

Canada

DEDICATION

For my mother, Gladys Turner, who would have been proud

and my husband Robert Shaw, who is.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my supervisor, Dr. M. W. Gillespie for his advice and guidance throughout my graduate program. I would also like to thank my examining committee: Drs. H. Northcott, J. Golec, L. Reuter, A. Thompson and W. Avison for their valuable comments and critique.

I would also like to thank Jonathan Robb for his valuable assistance with developing the study protocol, and boundless energy during data collection and analysis.

I am also deeply indebted to Robert Shaw for his unflagging support throughout the years it took to complete this project.

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION 1

STATEMENT OF THE PROBLEM AND RELEVANCE 1

OBJECTIVES 4

DATA SOURCES 5

ORGANISATION OF THE THESIS 6

CHAPTER 2: THEORY AND PREVIOUS LITERATURE 7

THE DEFINITION OF STRESS 9

ENVIRONMENTAL DEMANDS 13

Measuring Major Life Events 14

Measuring Daily and Weekly Stressors 21

Measuring Chronic Strains and Role Stressors 25

APPRAISAL OF DEMANDS 30

Measuring Psychological Resources 32

Measuring Social Resources 35

PERCEIVED STRESS, BENIGN APPRAISAL AND NEGATIVE EMOTIONAL RESPONSE 42

Physiological or Behavioural Responses and Increased Risk of Disease 51

SUMMARY 52

CHAPTER 3: METHODS 56

STUDY DESIGN 56

HYPOTHESIS AND RESEARCH QUESTIONS 56

OPERATIONALIZING THE HYPOTHESES 58

ANALYSIS 60

DATA SOURCES 61

RELIABILITY OF MEASURES 64

SAMPLE CHARACTERISTICS 65

MEASURING ENVIRONMENTAL DEMANDS 65

Sample Characteristics 66
Healthy Behaviours and Chronic Diseases 67
Major Life Events 69
Weekly Stress Inventory 72
MEASURING THE ABILITY TO ADAPT 74
Psychological Resources 75
Social Resources 76
MEASURING SELF-PERCEIVED STRESS 80
MEASURING NEGATIVE EMOTIONAL RESPONSE 84
MEASUREMENT OF PHYSIOLOGICAL RESPONSE 86
MEASUREMENT OF HEALTH CONDITIONS 87
CHAPTER 4: CORRELATION ANALYSIS 91
ENVIRONMENTAL DEMANDS 91
APPRAISAL OF DEMANDS: PSYCHOLOGICAL AND SOCIAL RESOURCES 109
SELF-PERCEIVED STRESS 114
NEGATIVE EMOTIONAL RESPONSE 116
SUMMARY 117
CHAPTER 5: TESTING THE COMPLETE MODEL 119
DEFINING THE LATENT MEASURES OF THE APPRAISAL PROCESS 121
MODELLING THE STRESS PROCESS 128
SUMMARY 143
CHAPTER 6: DISCUSSION OF THE RESULTS 144
CHARACTERISING THE RESPONSE TO STRESS AS NON-SPECIFIC 144
MEASURING THE STRESS RESPONSE 150
THE RELATIVE SIGNIFICANCE OF THE MEDIATORS 154
EFFECT OF SOCIAL AND PSYCHOLOGICAL RESPONSES ON DIAGNOSIS 159
SUMMARY 162
CHAPTER 7: CONCLUSION 163
SUGGESTIONS FOR FURTHER RESEARCH 167

REFERENCES.. **173**

LIST OF TABLES

Table 1: Self-Reported Chronic Diseases 69

Table 2: Frequency of Experience of Major Events 70

Table 3: Mean Weighting Score for Events Scales 71

Table 4: Measures of Weekly Stress Inventory 72

Table 5: Measures of Psychological Resources 75

Table 6: Measures of Social Contact 76

Table 7: Measures of Anomia and Alienation 77

Table 8: Measures of Social Disconnection 79

Table 9: Frequency of Response to Self-Perceived Stress 81

Table 10: Percentage and Average Experience of Emotions in Previous Few Weeks 82

Table 11: Measures of Anger, Depression and Tension 86

Table 12: New Physician Diagnoses by Category 89

Table 13: Correlation of Community with Measures in the Model 93

Table 14: Correlation of Gender with other Measures in the Model 94

Table 15: Correlation of Age with Measures in the Model 95

Table 16: Correlation of Chronic Disease Diagnosis with Measures in the Model 96

Table 17: Correlation of Body Mass Index with Measures in the Model 97

Table 18: Correlation of Major Life Events with Measures in the Model 98

Table 19: Correlation between Event Scales and Endogenous Measures 100

Table 20: Correlation between the Weekly Stress Inventory and the Measures of Appraisal, Self-Perceived Stress and Negative Emotional Response 102

Table 21: Correlation between Community, Gender, Age, Chronic Disease and BMI and Diagnosis.. 105

Table 22: Correlation of Major Life Events with Diagnoses.. 106

Table 23: Correlation between Composite Event Scales and Diagnosis 108

Table 24: Correlation between the Measures of Appraisal and Other Measures 111

Table 25: Correlations between the Psychological and Social Factors in Appraisal and Diagnosis.. 113

Table 26: Correlation between Arousal and Self-Perceived Stress and Negative Emotional Response.. 115

Table 27: Correlation between Arousal and Self-Perceived Stress and Diagnosis 116

Table 28: Correlation between Negative Emotional Response and Diagnosis............... 117

Table 29: Measures of Significance of the Model 120

Table 30: Item Reliabilities and Loading of Exogenous Measures on Latent Variables 123

Table 31: Standardised Direct Effects of Latent Variables on One Another.................. 124

Table 32: Effects of Environmental Demands on Endogenous Variables...................... 127

Table 33: Five Steps in SEM Analysis of Direct Effects of Latent and Exogenous Variables on Circulatory Disease.. 133

Table 34: Five Steps in SEM Analysis of Direct Effects of Latent and Exogenous Variables on Diabetes 135

Table 35: Direct Effects of Latent and Exogenous Variables on Disease Diagnoses 140

Table 36: Diagnoses Directly or Indirectly Affected by One or More Events 142

LIST OF FIGURES

Figure 1: The Stress Process Model Defined By Cohen, Kessler And Gordon 7

Figure 2: Component Plot for Emotion Items... 83

Figure 3: Measures of Latent Variables.. 122

Figure 4: Causal Model of Social and Psychological Variables..................................... 125

CHAPTER 1: INTRODUCTION

STATEMENT OF THE PROBLEM AND RELEVANCE

In the early part of the 20th century, Hans Selye proposed a medical model that defined how stress might affect human health. Selye's research provided some evidence that there is a non-specific physiological response to stressful external events, and that this non-specific response was the precursor to disease. Selye also proposed that there are three stages to the response to environmental demands: an alarm reaction, a stage of resistance and a stage of exhaustion. Disease develops during the stage of exhaustion.

Since the initial presentation of the theory by Selye, considerable effort has been applied to defining the relationship between stressful life events, individual personality variables and social status variables, and their differential effects on both physical health and psychological distress. The concept that external events could have an effect on health outcomes offered a potential to identify factors in the etiology of disease over which some influence could be exerted and thereby decrease disease prevalence. Researchers have sought to understand which external factors have an impact on health, and which health conditions are affected, assuming that these influences could be modified and thereby decrease the incidence of disease.

A very large body of research has developed that defines a number of psychological and social processes or responses that mediate the effect of environmental demands or stressors on health and identifies a number of health conditions associated with stress, such as coronary heart disease, type 2 diabetes, early onset of labour and increased susceptibility to colds. Furthermore, studies have demonstrated that significant life events that occur throughout the life span, including childhood traumas such as sexual, physical and psychological abuse, and parental divorce or substance abuse, and adult traumas such as divorce and job loss, are also related to psychological distress or other adverse health conditions (Turner, 1995).

However, the relationship between stressful life events and health conditions is complex and difficult to measure. Most of the research has focused on one component process of the stress model, and few researchers have investigated the complete scope of the stressor process. Researchers frequently focus on only one aspect of the stress process, depending upon the discipline from which they base their approach. For example, social researchers tend to focus on differential exposure to stressors arising from the social structure; social psychologists focus on the ability of the individual to cope with the stressors; and health researchers focus on the physiological mechanisms through which biological changes can occur. Often this focus drives different choices for outcome measures, so that the dependent variable in one type of approach may be the independent variable for another approach, making comparison of the results difficult or impossible.

Furthermore, the choices made about the method of measurement often restrict the ability of the researchers to make predictions: studies which collect information at a single point in time can not accurately measure events in the past, nor make accurate predictions about health outcomes in the future; studies which focus on specific populations with a clearly diagnosed condition are forced to make assumptions about the applicability of the theory to healthy populations who experience the same stressors, and so on.

Initial research focused on defining the measurement tools for identifying the environmental demands. The focus then shifted to defining the social and (primarily) psychological factors which mediate the effects of environmental demands on health outcomes. Significant progress was made toward developing an understanding of the process, and current research now focuses more on applying the stress process model to a variety of different situations and conditions. However, there has been very little effort to apply the complete process model to a single sample population, using consistent measures, and a variety of diagnoses.

Thoits (1995) argued that much of the social psychological literature has focused on using only a single indicator of health outcome, and most frequently that indicator is a measure of depression or other psychological impairment. Using these indicators as outcome measures confounds the analysis because the measures for the independent and dependant variables often overlap.

A research program which encompasses the full spectrum of the stressor → health outcome relationship would be able to determine the relative importance of external demands, personality characteristics, and social psychological responses to those demands. Furthermore, this approach to the problem would be able to more clearly determine if the response to stressful events could be classified as a non-specific response, or if the characteristics of the individual and their social environment are the unassociated with disease.

The research discussed below encompasses a more extensive application of the general model proposed by Cohen, Kessler and Gordon (1995) than is typically evident in the literature. The present analysis incorporates indicators of each component of the model, using data collected from a volunteer sample of the general population to assess the relative contribution of each of the mediating variables in the model. This approach is unique in both the breadth of scope (few researchers have assessed the full scope of the model on several different disease groups) and in the explicit emphasis on specific components in the model, which have not previously been well evaluated, but are nevertheless key underlying assumptions. Testing the full model also addresses the confusion that arises from defining variables that are intermediate in the stress process as outcome variables. The measure of diagnosis used for the analysis was obtained from administrative records of visits to a physician after the data collection period, which allows for a prospective study design and ensures that the issues of temporal order are controlled. Including all diagnosis categories also provides a more extensive scope than has been undertaken by other researchers because the impact of stress on potentially all disease outcomes can be evaluated. Finally, analyzing a variety of different disease categories will also address the question of whether the response to stressful events is non-specific or only affects specific physiological processes, when combined with certain social and psychological attributes.

OBJECTIVES

The objective of the research discussed below is to determine whether the response to external events or stressors can be characterised as a general non-specific response, or if the response to external stressors only results in specific disease categories. A second objective is to determine the importance of the social and psychological responses in the stress process and whether external stressors have a direct impact on health, or if the effect on health is only caused by ineffective social and psychological responses to external stressors.

Two secondary objectives were: to evaluate the viability of measuring the stress response using a measure of arousal; and to evaluate the significance of the individual's perception of society as supportive or harmful in the stress process.

The specific questions to be addressed are:

1. Can the response to external events be characterised as non-specific? That is, do the external environmental demands affect a wide variety of diagnoses, independently of the social or psychological mediators in Cohen's model?
2. Can the stress response (Selye's alarm stage) be measured?
3. What is the relative significance of the social and psychological mediators in the model? and
4. How do the social and psychological responses to stressful events affect health outcomes?

DATA SOURCES

The data for the analysis were obtained through a study conducted in three communities in northern Alberta to assess personal exposure to airborne contaminants. Although the original study was designed to evaluate the health effects of exposure to airborne contaminants, the scope and content of the data collection instruments were developed with the consideration of the processes outlined in Cohen, Kessler and Gordon's model (discussed in detail in Chapter 2). The study was conducted in three separate communities over a five year period. Several measures were added to the survey instruments for the second and third communities, but the protocol was not otherwise altered, and the minimum standard questionnaire was administered to all respondents.

Factor analysis was used to evaluate the validity of the scale construction, and correlation analysis was used to filter out possible causes or predictors that are independent of the dependent variables. Structural equation modelling techniques were used to evaluate the full model including all the measures. The main advantage of using structural equation modelling (SEM) is that it combines factor analysis and multiple regression to evaluate a number of relationships simultaneously. This is a particularly significant feature, given the complexity of the stress process model and the number of variables that must be considered by the analysis.

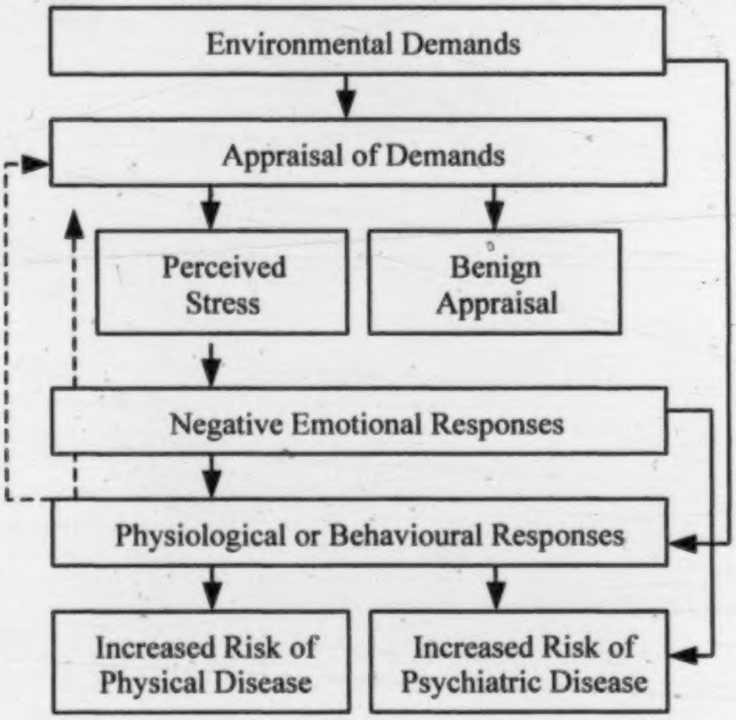
ORGANISATION OF THE THESIS

The results of the research reported in this thesis are organised as follows: Chapter 2 outlines the key literature and the issues associated with each different theoretical approach to measurement of stress and health outcomes. Chapter 3 outlines the study design, data sources, and provides an overview of each of the measures included in the model, including the results of the initial factor analysis used for scale development and evaluation. Chapter 4 reports the results of the initial correlation analysis, and Chapter 5 outlines the results of the analysis using structural equation modelling techniques. Chapter 6 discusses the results and Chapter 7 summarises the findings and addresses the implications.

CHAPTER 2: THEORY AND PREVIOUS LITERATURE

Cohen, Kessler and Gordon (1995) offer an heuristic model describing the various components of the stress process model and describing how the various components all fit together, based on the large body of literature providing evidence of each step in the process (see Figure 1). A number of variations of the model have been assessed and discussed in the literature (see Dohrenwend and Dohrenwend, 1981; Lazarus and Folkman, 1984; Lyon and Werner, 1987; Melmed, 2001) but with very little variation in the stress processes that would need to be included in any analysis.

Figure 1: The Stress Process Model Defined By Cohen, Kessler And Gordon


Environmental Demands
Appraisal of Demands
Perceived Stress
Benign Appraisal
Negative Emotional Responses
Physiological or Behavioural Responses
Increased Risk of Physical Disease
Increased Risk of Psychiatric Disease

According to this model, the stress process begins when an individual is exposed to external or environmental demands typically referred to as 'stressors'. The individual evaluates the external demand to determine if it poses a threat, and whether the individual believes he or she has access to enough resources to cope with the demand. If the individual determines that the external demands exceed their ability to cope, and the demands continue unabated, he or she will become aroused and exhibit negative emotional states. The evaluation of the external demands and the coping resources is an iterative process, which may result in reassessment of the external demand as unimportant, or in reassessment of the external demand as significant and warranting ongoing arousal. According to the model, extended negative emotional states may lead to behavioural responses and increased risk of psychiatric disease. A number of researchers (e.g. Brown and Harris, 1978; Depue and Monroe, 1986) have found that psychiatric episodes may be precipitated by stressful events, but only for individuals who already have been diagnosed with the disease, indicating that diagnosable mental health conditions are not caused by stress but that stress can only exacerbate a pre-existing condition. On the other hand, there is some evidence that extended negative emotion states such as anger may result in excessive hormonal secretions or other physiological changes, which ultimately result in physical illness such as heart disease.

Other models of the stress process generally include the same processes, but define a different relationship among them. Some researchers, for example, have argued that the availability of social or psychological resources moderates, rather than mediates, the effect of events on health. This model is difficult to test using structural equation modelling techniques, and was therefore not fully tested by the current analysis.

Most researchers continue to focus on only one or at most two processes in the model, and many consider other components of the model to be separate theoretical perspectives at odds with their own. Distinctions of nomenclature that define stress as an external factor, stress as an internal response, or stress as a transactional process further confuse the issue and often lead researchers to ignore other components in the model, resulting in unproductive detours and unnecessary conflict.

The process as defined by Cohen, Kessler and Gordon was used as a model to determine the appropriate variables to be used in the analysis for this thesis, and also defined the themes of the literature review below.

The literature on stress and health outcomes is massive, and continues to grow each year: approximately 5000 to 7000 new articles are published on the stress process and the relationship to specific health conditions each year, and numerous reviews of the literature have been done by other researchers. Consequently, rather than replicate that effort, the literature review below focuses on the key developments in measurement of the processes in Cohen's model, as required to place the analysis in context.

THE DEFINITION OF STRESS

According to Taber's Medical Dictionary, stress is defined as:

> …the result produced when a structure, system or organism is acted upon by forces that disrupt equilibrium or produce strain. In health care the term denotes the physical (gravity, mechanical force, pathogen, injury) and psychological (fear, anxiety, crisis, joy) forces that are experienced by individuals. It is generally believed that biological organisms require a certain amount of stress in order to maintain their well-being. However, when the stress occurs in quantities that the system can not handle, it produces pathological changes. This biological concept of stress was developed by Hans Selye who intended originally for stress to

> indicate cause rather than effects. But through a linguistic error, he gave the term stress to effect and then later had to create the word *stressor* for the cause.[1]

As a novice physician, Selye (1956) noticed that the early symptoms of an illness, poisoning or allergic reaction were similar across all patients, regardless of the illness. It was only after the specific symptoms appeared that the physician could begin to identify the specific disease and prescribe medicines to treat that illness. The general symptoms intrigued Selye, those symptoms he called the "syndrome of *just being sick.*" These symptoms characterise general illness, but not any specific disease. Selye attempted to show how both physical and psychological stressors led to a series of non-specific biological responses.

Selye injected rats with chemicals (e.g. Formalin) and noted a consistent triad pattern of physiological changes: enlargement of the adrenal cortex, atrophy of the thymus gland and lymph nodes, and the appearance of gastrointestinal ulcers. He also recorded elevated eosinophil cell levels. This cluster of physiological responses were part of a syndrome Selye called the *General Adaptation Syndrome* (G.A.S.), which consists of three stages of response to any noxious stimuli:

1. An alarm reaction;
2. A stage of resistance; and
3. A stage of exhaustion.

According to Selye, the sequence remains the same, regardless of the type of noxious stimuli, although the response may not run through to completion of the final stage if the stimulus is removed. Selye's experiments emphasised the relationship between chemical or biological stressors and adverse health outcomes, but he later expanded his theory to include both physical and emotional forms of stress.

---

[1] Taber, CW. 1981. Taber's Cyclopedic Medical Dictionary, F.A. Davis Company, Philadelphia.

Selye distinguished between the specific effects induced by a stressor agent and the effects induced by such stimulation which are not specific to it. For example, according to Selye's theory, intense cold produces one physiological response, and intense heat produces a different response, but if both are continued for long enough, the organism responds with the same reaction, not specific to either stimulus. Selye considered the common responses to be a *systemic stress response*. In Selye's model, stress is defined as "a state manifested by a syndrome which consists of all non-specifically induced changes in a biological system." It is the responses that are common across agents, rather than the ones that are unique to a specific diagnosis that are the focus of Selye's theory of stress response.

Although Selye's experiments focused on injecting rats with noxious chemicals, he did identify a relationship between the chemical or biological stressors and consistent adverse health outcomes. Selye also did not limit his description of the biological effects of stress to negative events. According to his original conceptualisation, he argued that many types of events, such as "crossing a busy intersection, exposure to a draft, or even sheer joy are enough to activate the body's stress-mechanism to some extent. Stress is not even necessarily bad for you; it is the spice of life for any emotion, any activity causes stress" (preface, 1956). Selye coined the term *eustress* to refer to a stressor to which the individual is able to easily adapt, and *distress* which refers to stressors that are prolonged, or to which the individual is not able to adapt as easily. It is the ability or inability of the individual to adapt their behaviour to reduce the impact of the stressors that results in a greater or lesser degree of physical response and consequent adverse health outcomes.

Unfortunately, Selye's experiments were not easily replicable, and the experimental models are difficult to apply to human responses. Furthermore, the scientific techniques required to measure minute physiological responses to exposure to chemical stressors in humans are not well defined. For example, subsequent research has shown that an elevated eosinophil cell count can result simply from the stress associated with the sampling procedure (e.g. the sight of a needle), and can also indicate the presence of an enteric infection which is clearly unassociated with the stress process. Consequently, most research has focused on identifying the health outcomes resulting from exposure to psychological stressors and to modelling the effects of potential mediators in the relationship.

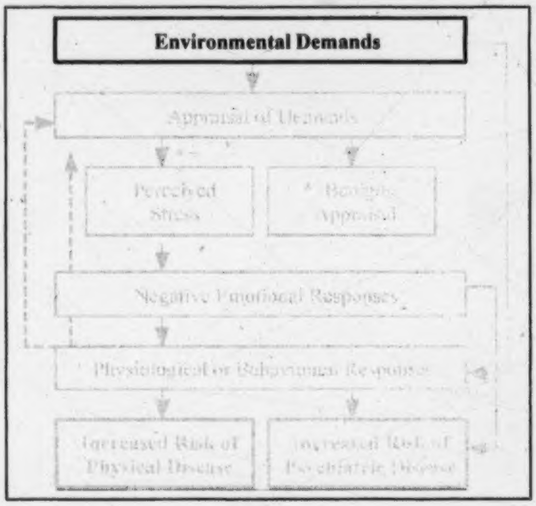
Selye's original discussion offers two key hypotheses that will be evaluated for the present analysis. The first hypothesis is that stress leads to non-specific biological responses. Selye identifies a similarity across the symptomatic complaints initially made by patients that lead to a variety of different diagnoses. Selye calls these general symptoms 'non-specific responses'. According to Selye's hypothesis, stress is implicated across the spectrum of diseases, because high levels of stress cause these non-specific responses, and with continued exacerbation from the external stressors, develop into identifiable diseases. In order to evaluate this hypothesis, the current analysis will evaluate the impact of the stress process on a variety of disease categories - if external stressors cause a non-specific biological response, the effect of those external stressors should be evident and consistent across a variety of disease categories.

The second of Selye's hypotheses that was evaluated in the current analysis is his argument that stress results from a disruption of equilibrium, and that the disruption would be evident in the three stages of the General Adaptation Syndrome (alarm, resistance or exhaustion). The current analysis includes a measure of arousal which is hypothesized to correspond to the alarm stage – individuals who are experiencing an alarm reaction should show evidence of a greater level of arousal (in the form of a more volatile emotional state and frequent experience of a variety of emotions), and the level of arousal should have a measurable effect on disease.

Selye's work provided the basic groundwork for research in a variety of fields, many of which focused on identifying the processes of only one part of the stress process model. Next we will consider the development of the literature and the tools to measure the different components of the stress process.

ENVIRONMENTAL DEMANDS

The first step in Cohen, Kessler and Gordon's model is the exposure to external or environmental demands (highlighted in black on the diagram at right). These demands are typically referred to as stressors but also included in this category are other risk factors such as age and sex. Mirowsky and Ross (1989, 1995) found significant age- and gender-based differences in distress and depression.


Environmental Demands
Appraisal of Demands
Perceived Stress
Benign Appraisal
Negative Emotional Responses
Physiological or Behavioral Responses
Increased Risk of Physical Disease
Increased Risk of Psychiatric Disease

The type of environmental demands for which measures have been developed include major life events, daily or weekly hassles and events, chronic stressors and role strains. The earliest work in the field of stress research focused on the development of measurement tools to determine which life events might cause stress.

Measuring Major Life Events

Holmes and Rahe (1967) focused on the measurement of significant life events, based on the assumption that if any association between events and health outcomes could be measured, it should be most evident as a result of catastrophic events. They argued that the number and type of stressful events are not as important as the amount of change or readjustment required, and the duration of the impact of the stressful event. In order to test this premise, they developed a tool to measure the magnitude of the impact of stressful events. The Social Readjustment Rating Scale (SRRS) was developed to provide a weighting for each event according to the amount and duration of readjustment required. Marriage was arbitrarily chosen as the base to which all other events were compared, and study participants were asked to rate all events according to whether they considered the event as more or less stressful than marriage. Holmes and Rahe then compared responses across groups of people within the participant sample to determine the consistency of scoring across the population.

Holmes and Rahe used a psychophysical methodology called 'magnitude estimation' to develop the weighting scheme, based on the assumption that an individual could use the "innate psychological capacity for making quantitative judgements about psychosocial phenomenon as well as psychophysical phenomenon" (1967, p. 217). The original list of events was developed to document the major life events experienced by

TB patients prior to the onset of clinical symptoms (Hawkins, Davies and Holmes, 1957), but the weighting scheme was developed independently of any associated health outcome evaluation. It is important to note that, while Holmes and Rahe conducted a number of studies to validate the consistency in weighting across groups, they did not validate the scale by testing to see if the scale predicted either disease or a psychological response to stress.

Holmes and Rahe found that the psychological and emotional significance of an event varied greatly across individuals but that the assessment of the amount of readjustment required for a given event (called Life Change Units) was relatively consistent across different population groups. Rather than measuring the ability of the individual to adapt, they focused on the total amount of change caused by the event, including both negative and positive life events.

As soon as Holmes and Rahe published the results of their analysis, a number of criticisms of the approach and structure were raised. Brown and Harris (1978) argued that the measurement of the causal link between events and health outcomes using the model developed by Holmes and Rahe is methodologically flawed. According to Brown and Harris, Rahe's scale lacked the specificity required to make it useful, and may have introduced systematic bias into any research using this type of scale. The results, according to Brown and Harris, may be affected by the individual's interpretation of the relative importance of the event. In other words, the respondent may interpret some events as being more stressful because they have an illness that they believe is caused by exposure to stress. Furthermore, the Social Readjustment Scale doesn't differentiate between positive and negative events to enable research to determine which type of event has a significant impact on health outcomes.

Brown and Harris attempted to address these concerns by developing a more rigorous tool for defining the significance of an event, assuming that the occurrence of an event, and the magnitude of the event as measured by an independent observer, is the defining factor in whether the event will cause a physiological response. However, after applying the tool, they found that interpretation of the importance of the event by the individual was a more significant predictor than the mere occurrence of the event. Although not acknowledged, their findings provide support for the argument they were criticizing – that the individual's interpretation of the event is of critical importance in the impact of the event.

Brown and Harris conducted a number of large scale studies of the impact of stressful events on psychological illness, testing the basic premise that change has an impact on mental health. However, Brown and Harris used a retrospective approach and involved only patients diagnosed with psychological conditions. They recorded the occurrence of all types of events, and found that events - or more specifically, any event that sufficiently aroused the individual - precipitated a schizophrenic episode, although the size of the relationship was small. They found that this was true for both positive and negative events. Furthermore, the effect of life events on schizophrenic episodes was additive in their study: two events are more likely to bring about an illness than one.

As one would expect, the relationship between positive stressors and health outcomes did not hold true when the outcome under investigation was depression. According to Brown and Harris, the interpretation or meaning of the event and the other resources available to the individual, such as supportive relationships, had a moderating effect on the impact of the provoking factor or stressful event. Brown and Harris argued that a provoking factor or stressful event is not sufficient to bring about depression, but may determine when a disorder occurs.

Brown and Harris focused their research efforts on population groups already diagnosed with mental health disorders such as schizophrenia and clinical-level depression, which precluded their ability to determine if there was a physiological response to the major life events that created these conditions. In fact, a significant amount of the literature published since Brown and Harris's work discusses research that uses sub-clinical depression as an outcome measure, and avoids the evaluation of external stressors on physiological responses altogether.

The Dohrenwends and their colleagues (1978) also tried to address the problems with the tool developed by Holmes and Rahe by refining the methods used to develop the original tool. The development of the Psychiatric Epidemiology Research Interview (PERI) Life Events Scale included a number of studies using different population groups and provided evidence that the experience and interpretation of life events is different across sub-groups of the population. Dohrenwend et al found that there were differences in the rating of an event across the status groups defined by class, ethnicity and gender. The Dohrenwends conducted a number of studies where they applied this and other scales to measure the impact of stress and maintained that change has an adverse effect on a variety of disorders, such as schizophrenia, depression, and antisocial personality disorder. As with the research conducted by Brown and Harris, the work by the

Dohrenwends and their colleagues did not determine whether the effect of external events on these conditions was causal or merely precipitous.

More recently, Scully, Tosi and Banning (2000) evaluated the Social Readjustment Rating Scale (SRRS) developed by Holmes and Rahe, to assess the validity of the weights assigned 30 years ago, and to assess the predictability of the scale. They did find that weights and relative importance had changed in the time since the original work by Holmes and Rahe. In applying the new weighting, however, they found adequate support for continuing to use the weighting scheme approach to the measurement of major life events. Their research reflected the findings of other studies: life events that occurred within the previous 12 months are more strongly associated with symptoms than events that occurred at a more distant time, and that all types of events (desirable, undesirable and neutral) had some predictive value when symptoms or complaints are used as outcomes.

Rather than develop another scale, Ross and Mirowsky (1979) evaluated the different methods of weighting life events in terms of how well they predict psychiatric symptoms (rather than measuring consistency of weighting across social or cultural groups). Using a series of events that were common across the existing scales, they compared analysis techniques that measured change with techniques that measured desirability, and compared the predictability of 23 different methods of weighting the same scale. The comparison focused on the differences in the methods used to weight the scale or to calculate the impact of stressful events, and the same sample population was used for each scale to negate the impact of sampling differences.

Ross and Mirowsky concluded from this analysis that the approach which yielded the greatest predictability was the application of weights to events that are proportional to the mean effect of the event on the dependent variable in a specific population, controlling for effects of other events. In other words, they developed a weighting scheme that involved conducting a multiple regression analysis of the impact of each stressor on an outcome measure, and then applying the regression coefficient to weight the items in the scale. The proposed method was called Effect-Proportional Weighting. They argued that this method predicted outcomes better than any other method.

Ross and Mirowsky argued that Effect-Proportional Weighting supported Selye's original hypothesis, arguing that "stressfulness is not inherent in an event. Nor is it in the eye of the observer, like desirability and change. Stressfulness is a function of the response of the distressed" (p. 169, 1979). They suggested that:

> 1. Life change is a property based on subjective estimates of magnitude. The basic model is psychosocial.
> 2. Undesirability is a property based on normative judgements. The basic model is social-psychological.
> 3. Stressfulness is a property based on observed responses. The basic model is behavioural (stimulus-response). (p. 169, 1979).

Therefore, if stressful properties of an event are inferred from the responses, events could be weighted in proportion to their statistical effect. According to Ross and Mirowsky, their research suggests that symptoms are associated with the undesirable nature of an event more than the total number of events. However, they argued that Effect-Proportional Weighting reflects 'pure stressfulness', which was a better predictor than undesirability. However, this technique was not well-accepted, because it would result in a different weighting scheme for each study, and would be different across population groups, so it could not provide a reliable weighting scheme to achieve consistent results across populations.

Ross and Mirowsky also evaluated the relative predictability of a scale based on measuring the desirability of an event compared with a scale based on measuring the amount of change. They found that the most predictive undesirability scale is a simple addition of the number of events, and that undesirability scales predict symptoms better than change scales. According to their analysis, when they controlled for undesirability of events, the effect of desirable events, change, and the number of events disappears.

The main argument against stress research that focused on the impact of events on health outcomes put forward by Thoits (1982) was that the correlation between events and health diagnosis was consistently quite small (between .10 and .30), and despite the large volume of research literature that focused on the development or refinement of the event scale and associated weighting schemes, this has remained consistent. Werner and Frost (2000) identified 55 different scales for measurement of major life events that have been developed in the thirty years that have passed since Holmes and Rahe first published their scale. The majority of these scales tailor the questions to the population under evaluation, based on the recognition that many population groups are not exposed to a significant portion of the major life events used in standard inventories. For example, children and college students are unlikely to be exposed to events such as death or divorce from a spouse, and a standard scale of major life events would consequently underestimate the level of stress for these population groups. These targeted scales include events more appropriate to the study population such as pressure from final exams for college students, parental concerns about caring for a child with serious health problems, and experiences associated with war atrocities. However, as Turner and Wheaton pointed out in 1995, the magnitude of the relationship remains relatively constant, regardless of which checklist is used.

Werner and Frost (2000) also identified a potential classification scheme for organising major life events that defines the different dimensions associated with a particular life event. The dimensions identified in their summary of the literature included: locus, forecasting, tone, temporality, duration and frequency, impact on family and social roles, and context. Werner and Frost suggest that the classification scheme could be used to identify the characteristics of the environment that influence health, and recommend a course of research focusing on addressing this question. While it may be fruitful to explore this classification scheme, the focus of the questions that would be addressed by this approach are somewhat oblique to the main question of the impact of stressful life events on health outcomes.

Measuring Daily and Weekly Stressors

Another approach to the measurement of events was to change the focus from major stressors to look instead at measuring daily or weekly stressors. For example, DeLongis, Folkman and Lazarus (1988) suggested that monitoring the stress of daily living and health related symptoms, rather than major illnesses, might provide stronger evidence of the stress process. This alternative focus, they argued, would also support the identification of individual variation patterns by comparing an individual's responses over time, rather than comparing one measure at one time across individuals.

The Hassles and Uplifts Scale was developed by DeLongis, Coyne, Dakoff, Folkman and Lazarus in 1982, and was later refined by DeLongis, Folkman and Lazarus in 1988 to remove redundant items and items related to physical or psychological outcomes. The Hassles and Uplifts scale measures daily variation in the magnitude of irritation or satisfaction obtained from daily events or situations, rather than major life events. The scale was designed to be used to measure the impact of daily hassles on daily fluctuations in mood and health such as headaches and backaches, but application of the daily scales without considering major life events is not likely sufficient to address the general model of the effects of stress on health outcomes.

The Daily Stress Inventory developed by Brantley, Waggoner, Jones and Rappaport (1987) was also designed to measure daily variations in exposure to stressful events. Similar to the tool developed by DeLongis et al discussed above, this measurement tool also includes an improvement over the application of an objective weighting of the impact of the event, by providing a mechanism to measure the respondent's evaluation of the importance of the event, although Brantley's scale uses a 7-point Likert scale, whereas the Hassles and Uplifts Scale uses a 3-point scale.

Another approach to the measurement of daily stress is the daily diary, developed first by Meyer and Haggerty in 1962, and later redeveloped by a number of researchers (Eckenrode & Bolger, 1995). Measurement of daily events using a diary approach is useful for understanding the mechanisms by which stressors affect each other, for measuring exposure to stressful situations (as opposed to major events), understanding the impact or relative importance of different types of daily stressors, and measuring the extent to which daily events contribute to chronic stressors and the extent to which they mediate major events.

Daily measures are most appropriate for measuring arousal and the individual's response to daily fluctuations, rather than health outcomes from major stressors, and correspond closely with Selye's concept of *eustress*. However, obtaining daily measures puts a significant burden on the respondent, and the rate of participation or co-operation declines rapidly. Furthermore, daily measures require specific analytic techniques to account for variations in sampling and variations in repeated measures (across multiple days within an individual).

The premise on which the development of daily measures was based argues that stress related disorders may fluctuate daily. This premise ignores the fact that the diseases in question (e.g. diabetes, lupus, asthma) develop over a period of time, and identifiable fluctuations in symptoms are only symptomatic of the exacerbations caused by additional events, but do not relate to the original onset of the disease. The current analysis focuses on major disease categories, and measures of the daily fluctuations in minor stressors is not as relevant to the analysis or the stress process as the measurement of major stressors which have a lasting effect.

Finally, focusing on daily or weekly measures confounds the measurement of external stressors with the psychological response, because people who are more aroused and feeling more stressed (due to unmeasured events or external pressures) are more likely to complain about minor daily or weekly events, and to find them more significant. Including the measurement of the impact of the event on the individual further confounds the measure.

As with major life events scales, a number of scales have been developed to measure daily or weekly fluctuations in minor stressful events. The measurement techniques vary from recording responses to open ended questions through to structured checklists. For example, Jones and Brantley (unpublished, 1989) developed a weekly inventory to address the inherent weaknesses of measuring stress on a daily basis. According to Brantley (1997), the scale was derived from three existing daily measurement scales, using the broad domains used by the daily scales. The 87 items were restricted to include those events that were likely to occur in any week such as arguments with a spouse, and those events with a discrete beginning and end. Finally, items that could indicate either physical or psychological symptoms were excluded. Brantley argues that a weekly scale increases compliance, improves the evaluation of the duration over which an event occurs, and corresponds well with a variety of outcome measurement scales that can also be applied weekly. The scale obtains information about whether the event occurred in the previous week, and requires the respondent to rate the event in terms of the stressfulness of the event. The scale measures two dimensions of stress: the total number of stressful events, and the perceived impact for each individual.

These daily and weekly measures have not enjoyed the same popularity as the measures of major events, because the questions they aim to answer are quite different from the assumptions underlying the measurement of major life events and associated health risks. The association with serious health outcomes (rather than minor symptoms such as headaches) is difficult to measure with these tools; measures of daily and weekly stressors capture daily fluctuations in perception of events as stressful and the impact on mood and symptoms, but can not be used to measure the effect on the risk of serious health outcomes.

Measuring Chronic Strains and Role Stressors

Avison and Turner (1988) argued that typical life events checklists were restrictive in focus, and suggested that, with some modifications, a checklist could collect information about chronic life strains as well as major stressors. They emphasised the need to measure a variety of events, and argued that there is a need to distinguish between chronic strains and discrete events because each type of stressor has a different impact. Avison and Turner found that chronic strains had a significant effect on psychological distress, greater in fact than the impact of eventful stressors for some groups of people. They argued that the most likely reason why these have an influence on psychological distress is because the chronic strains were currently affecting the individual at the time of measurement - some discrete events that occurred in the 12 months prior to the study period may have been resolved and would no longer have an influence on psychological health. This argument applies to psychological symptoms such as negative mood, but is not as relevant to the consideration of major psychiatric episodes or diagnosable health outcomes.

Measurement of chronic strains assumes that prolonged coping with a chronic stressor may deplete biological resources over time (as proposed by Selye's model), or may result in a 'persistently heightened state of arousal" (Cannon, 1929). Prolonged coping may be psychologically fatiguing, could result in increased neuro-endocrine production, and could cause social avoidance, thereby diminishing social resources valuable in the coping process.

Chronic stressors refer to conditions or events that persist over time and include environmental stressors, economic stressors, role stressors, enduring interpersonal difficulties, and barriers to the achievement of life goals. According to Pearlin, adequate measurement of chronic stressors is cumbersome because of the potential numbers and diversity of stressors. Pearlin (1989) suggested a focus on the measurement of strains associated with social roles such as parent, employee, spouse. He identified a number of strains associated with social roles, including role overload, conflict within a role set, inter-role conflict, role captivity and role restructuring. He developed objective methods of measuring these role strains, although the sources of role strain were identified using interview techniques.

Measurement of role strains using role stressor questionnaires, while lucrative for describing social interactions and expectations, doesn't predict outcomes very well (Pearlin, 1989). Chronicity of a role strain is also difficult to establish empirically, and must be inferred. Another concern with focusing on role strains is that measurement of role strains may be confounded with measurement of health outcomes, particularly when the focus is on mental health. Furthermore, causal reciprocity may also artificially elevate the correlation between role strains and health outcomes when a physical health problem exacerbates conflicts associated with a role. Measurement of the duration of this type of stressor is also difficult because the onset of conflict or strain is often insidious. Finally, role occupancy is a prerequisite of role strain; consistent measurement across population groups is difficult because all people do not occupy all roles.

Lepore (1995) identified a variety of standardised and relatively reliable tools for measuring stressful aspects of the work or marital roles, the occupational environment, role ambiguity, lack of cohesion, and interpersonal conflict. According to Lepore, the Work Environment Scale developed by Moos to measure strains in the work environment is one of the few that is sufficiently objective to measure the stressfulness of the global work and marital environments rather than the individual's biased judgements which are affected by emotional state or other personal characteristics. He also identified a variety of measures of marital role stressors, and suggested that the Family Environment Scale, also developed by Moos, is the most objective measure of stressors in the marital domain. However, according to Lepore, although these objective self-reported checklists are useful for mapping role strains and associated role-related attitudes, they do not consistently predict health outcomes.

Another approach to measuring chronic events focuses on the measurement of lifetime traumas, such as abuse during childhood, or death of a parent at an early age. For example, Turner and Lloyd (1995) argued that lifetime traumas are vital to understanding the impact of cumulative adversity on mental health outcomes. They argued that a portion of the effect of major lifetime traumatic events on mental health is indirect, through eventful and chronic stressors. Furthermore, they argued that "differences in stress experiences arise, at least partially, from patterned differences in life circumstances that directly reflect the effects of social inequality or allocations of resources, status and power." Turner and Lloyd developed a checklist of events that could be used either as a self-completed questionnaire, or as part of an interview process. They contend that differences in life events account for a large proportion of the variation in psychological distress and that differential exposure to different stressors is significantly related to socio-economic status. They argued that stress was not properly measured, and that is the reason why researchers are becoming convinced that stress is unrelated (or only weakly related) to psychological health and depression. According to this argument, unmeasured exposures to stress across different social status groups are misconstrued as differences in vulnerability. By increasing the scope of the stressful events measured to include all lifetime traumas, Turner and Lloyd argued that a significant amount of the variance in psychological health outcomes is explainable, although this model was not tested on subsequent physiological diagnosis.

A variety of tools have been developed to retrospectively capture the stressful events or situations that occur throughout life which might have an impact on subsequent psychological or physiological health. For example, Bifulco, Bernazzani, Moran and Ball (2000) developed the Adult Life Phase Interview (ALPHI) to measure chronic stressors occurring during adulthood. The tool was designed to document events occurring over the lifespan using a semi-structured interview similar to that developed by Brown and Harris. The tool requires the investigator to make objective judgements about the stressful events, rather than relying on the subjective judgements of the respondent. The utility of the ALPHI tool is hampered by the same concerns as Brown and Harris's Life Events and Difficulties Schedule discussed previously: increased costs associated with a 1 to 2 hour interview, the potential biases introduced by the interviewer, and difficulty of achieving reliability between interviewers or raters.

According to Aneshensel, the distinction between chronic and acute stressors is artificial, and refers more to the duration of the exposure, rather than to the more important factor: the duration of the effect. "Acute stressors are typically defined as objective discrete events not resulting from psychological functioning, whereas chronic events are subjective, influenced by emotional functioning and lack a clear origin in time" (Aneshensel, 1992).

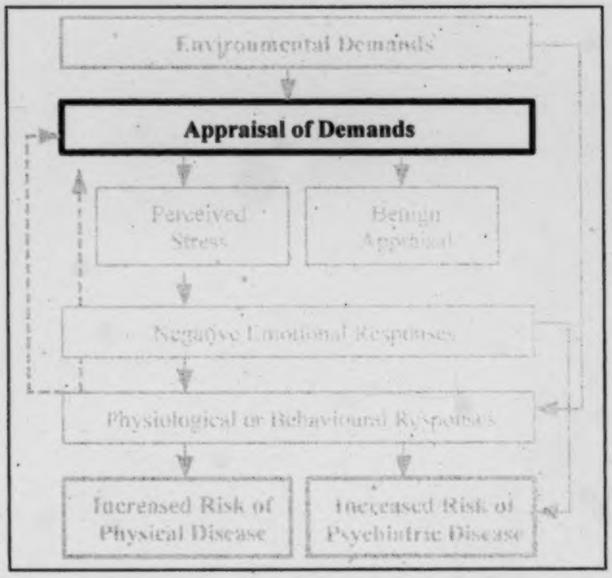
The measurement of stressful events has two main purposes which are not often recognised in the literature. The first purpose for measuring stressors is to identify which components of the external environment have an impact on an individual's ability to function normally. The goal of this approach is to identify elements that might result in differences in health across the social structure. The second purpose is to measure the impact on the individual or the response of the individual to the external events, that is, the amount of stress felt by the individual. These two goals are often confused and combined, and scales developed to measure both simultaneously cannot determine the separate effects of either. The method employed by Holmes and Rahe to develop the rating scheme was a valid assessment of the relative importance of each event to each judge in the study, but the attempt to sanitise the scale and apply the weights to all populations underestimates the value of each individual's assessment of the importance of an event and the associated health outcomes for that individual. Many of the refinements developed in the daily and weekly events lists attempted to identify the importance of the event to the individual, but changed the focus from the social structure to the microcosm of the individual's daily life. Furthermore, many of the events listed on these daily or weekly scales are often also used to define a psychological response, so that the measures of the independent variables are also included in measurement of the dependent variables. The focus on the measurement of chronic stressors and role strains was aimed at increasing the predictability of the outcome (self-reported depression), without considering first if there was an actual impact on health outcomes.

Despite the argument put forward by Thoits (1983) that the correlation between external events and health outcomes is consistently quite small (between .10 and .30), and that continued evaluation of events was unlikely to lead to a solution, recognition of the value of measuring life events to determine impact on health outcomes has not waned. Most of the current research, undertaken largely by the medical community, typically uses either the SRRS developed by Holmes and Rahe, or a variant that includes specific questions appropriate to the target population. This research has been able to demonstrate a relationship between major life events and a variety of health outcomes, including increase susceptibility to colds (Cohen, Tyrell, and Smith, 1991), type 2 diabetes (Mooy, De Vries, Grootenhuis, Bouter Heine, 2000), immunologic changes (see Jemmot and Locke, 1984 for review) and mental health (Turner, Wheaton and Lloyd, 1995). A recent study demonstrated that the appearance of new brain lesions in relapsing forms of multiple sclerosis are associated with "increased conflict and disruption in routine" (Mohr, Goodkind, Bacchetti, Huang, Marrietta, Cheuk and Dee, 2001).

The current analysis takes a similar approach by focusing the evaluation on the measurement of major life events to determine the impact of these events on a variety of diagnoses. A number of positive events were also included to determine the relative impact of positive events compared to negative events. In addition, the relative importance of smaller non-major life events was also considered through the inclusion of a measure of daily stressors, because Selye's original formulation suggests that both positive and seemingly insignificant life events caused a level of stress that eventually affect health outcome.

APPRAISAL OF DEMANDS

Cohen, Kessler and Gordon (1995) referred to the focus on the measurement of external measures discussed above as the Environmental Stress Perspective. An alternative approach to the evaluation of stress, labelled the Psychological Stress Perspective, emphasises the individual's "perception and evaluation of the potential harm posed by objective environmental experiences" (p.6). This perspective argues that an event is only stressful to an individual who perceives it to be so, and the focus of evaluation is placed on the individual's appraisal of the event and his or her ability to cope with the event through internal and external resources (highlighted in black in the diagram of Cohen, Kessler and Gordon's model at right).


Environmental Demands
Appraisal of Demands
Perceived Stress
Benign Appraisal
Negative Emotional Responses
Physiological or Behavioural Responses
Increased Risk of Physical Disease
Increased Risk of Psychiatric Disease

Pearlin (1978), Kessler (1979) and Thoits (1983) separately published seminal articles on the utility of measuring events and the poor predictability achieved with that method. The proposed alternative focused on measuring the ability of the individual to adapt their behaviour to reduce the impact of the stressors. Rather than emphasising the events or the amount of change that an individual might incur as a result of the event, this body of research emphasised the need to focus on the *interpretation* of the events and the strategies that individuals use to mediate the effects of stress. More importantly, this approach extracted the measurement of arousal from the measures of the independent variables and transformed the measurement of the impact of the event (the individual's level of arousal) into the dependent variable. Evaluation of the individual's ability to adapt has taken two different approaches: measurement of the individual's psychological resources, and measurement of the individual's social resources that can be used to mediate the effects of a stressful life event.

Measuring Psychological Resources

Perhaps the most influential work on appraisal and coping is the contribution by Richard Lazarus and his associates (Lazarus and Folkman, 1984). Recognition of individual differences in the perception of an event as stressful or not led Lazarus and his associates to propose that it is the cognitive process of appraisal of the event that leads an individual to define the event as stressful. According to this approach, stress is an internal process that is created through the perception of the individual. Lazarus suggested that an individual first evaluates an event to determine if it is benign or threatening, which Lazarus termed primary appraisal. Appraisal is a process of evaluating the event or situation to determine the social, cultural and personal importance of an event. If the individual determines that the situation or event poses a threat, the individual then evaluates his or her personal situation to determine whether he or she has the personal and social resources to mediate the threat. Personal resources refer to the individual's personality characteristics such as Type A personality, or hardiness, and the individual's belief in self-efficacy, often referred to as self-esteem, mastery, powerlessness, helplessness, hope or personal agency. Social resources refer to resources that can be brought to resolve a stressful situation such as moral or physical support from friends and family, financial resources, and other resources in the community.

According to Folkman and Lazarus, an individual may use a variety of coping actions to change the environment to reduce the impact of the stressful event, such as taking action to change the situation (typically called problem-focused), or to change the meaning of the event or situation (typically called emotion-focused). The appraisal of the situation and the evaluation of coping actions available continues throughout the duration of the event or situation, a process termed reappraisal, until the individual is able to determine that the situation or event no longer poses a threat.

Selye's description of the impact of stressors on health outcomes emphasised the importance of the ability of the individual to cope with the stressors, and the eventual breakdown of the organism when that capacity was exceeded. Folkman and Lazarus (1980, 1985, 1986) focused on this aspect of the theory and argued that cognitive appraisal of a situation and the particular coping strategies that the individual uses to address the stressful event have a mediating influence on the impact of stressful events on psychological health outcomes. Most of the work by Folkman and Lazarus was targeted at identifying and measuring the different coping strategies that people use, the relationship between coping strategies and appraisal of the situation, and differences across age and population groups. These studies found significant, although typically weak, relationships between coping and psychological symptoms.

Pearlin and Schooler (1978) compared the relative efficacy of coping resources (psychological characteristics) with coping responses (methods of dealing with the stressor) on self-reported stress levels. They found that efficacy depended upon the type of stressor - personal resources, such as a sense of mastery or personal control, and self esteem were more efficacious in areas where the individual had no control, and a wide repertoire of responses were more efficacious in close interpersonal relationships.

Pearlin and Schooler contended that stressful events are rooted in the structural context and that the observed relationships between social status and psychological outcomes must therefore be attributable to variations in exposure to stress resulting from these statuses. They argued that different coping mechanisms are required for different areas of life, and that failures may be due to the social structure rather than the individual. Pearlin suggested that variations in exposure arise out of 'developmental and contemporaneous conditions of life' (in other words, social causation), although they did not examine the developmental conditions to provide support for their argument.

Pearlin and Schooler argued against focusing on major life events because 'the difficult problems with which people cope are not unusual problems impinging on exceptional people, but are persistent hardships experienced by those engaged in mainstream activities within major institutions" (p. 3). Pearlin and Schooler referred to these as *persistent life-strains* and suggested that the response to stress is mediated by coping strategies. According to Pearlin and Schooler, there is no need to measure individual stressors, because the concept of stress is based on the assumption that all people experience all kinds of stressors, and if the individual doesn't have ways of coping with the stressors to alleviate their impact, then he or she will experience emotional strain. Consequently, Pearlin and Schooler used a measure of self-reported stress level as their dependent measure. Although their approach did not enable evaluation of the environmental demands placed on the individual, their approach did address the need to evaluate the non-specific stress response initially defined by Selye.

Pearlin and Schooler argued that stress can be broadly defined as the occurrence of discrete events and/or the presence of continuous problems; furthermore, the co-occurrence of both discrete events and continuous strains may have a synergistic effect. The experience of stressful events may change the meaning of existing strains, or life events may generate new strains. According to Pearlin, "emotional stress [as an outcome] is primarily distinguished from other negative states by it's specificity. It is specific in two related aspects: by being determined by particular strainful and threatening circumstances in the environment, and by being a condition that has clear boundaries rather than an enveloping, total state of the organism" (p. 4).

Measuring Social Resources

At the same time as these researchers were investigating the significance of the availability of psychological resources, a number of researchers were focusing on the social aspects of the coping and appraisal processes to determine how the social environment might have an effect on the stress process. In general, research on social resources has focused on the resources available and the individual's interpretation of their availability. The majority of the attention has focused on the evaluation of the different experiences of events and the differential impact of those events, depending upon the individual's role in society, including factors such as gender and socio-economic status as indicators of social marginalization. Initially, researchers investigated the impact of the social structure on health, particularly on mental health, using the assumption that different groups of people are exposed to different types and amount of stressful events because of their occupation of a particular social status or role. Dohrenwend and Dohrenwend (1969) and Srole (1956) separately identified a significant association between social structure and mental health. Gender (Nolen-Hoeksema; 1987) and marital status (Gove, 1972) have also been associated with mental health.

Turner, Wheaton and Lloyd (1995) examined a variety of different stressful events to determine if age, marital status or occupational status affect exposure to stressful events, and whether there is any association between these measures of social status and symptoms of depression. They found significant differences across these measures of social structure when a variety of different types of stressors were considered, indicating that people were exposed to different types of stressors, and that when all types of stressors are considered, there are significant differences in exposure by age, gender and occupational status. In addition, they argued that these differences accounted for differences in depressive symptoms. They did, however, concede that differences in vulnerability account for more of the causal effect on depressive symptoms than gender.

One of the problems with these objective measures of social status is that it is difficult to distinguish the root cause of the association with health outcomes. Occupational prestige, for example, is a generic measure that is used to identify a variety of variables, including income, social standing and respect, and access to other resources that could be used to alleviate the results of stressful events, but it also measures the higher stress levels associated with some types of employment, but groups the measurement of all these factors into a single score. Furthermore, these objective measures don't address the individual's emotional response to his or her occupation of that role, their role in society, or the stressfulness of the events to which he or she is exposed.

Kessler (1979) also argued that differential exposure to events does not account for the relationship between social status and psychological distress, because few studies have found significant results. Furthermore, as Kessler put it, "we simply find too many psychologically healthy people who have suffered extreme life crises, and too many psychologically distressed people who have experienced only their normal share of life problems" (p. 101). Kessler suggested that some people are simply more vulnerable than others to the psychological consequences of stressful life situations.

He argued that differential exposure accounts for less variation in psychological distress than differential *vulnerability*. He suggested that differences in reaction to stressors can be accounted for by the individual differences in the "force with which a stress impacts on the distress of an individual" (p. 101). He suggested that the differences in vulnerability are both "constitutionally and environmentally determined in a rather complex fashion." Kessler's term *vulnerability* is quite broadly defined, and encompasses a variety of more specific causal models, such as the buffering effects of social support networks, and different types of coping strategies.

Kessler (1979b) compared the effect of differential exposure with that of differential impact and found that differential impact is the more important determinant in the relationship between social status indicators such as marital status or gender and self-reported distress. Kessler (1984) further argued that women were more likely to report events as stressful that occurred to other people in their social network compared to men. According to Kessler, women were more vulnerable to the effects of events that happened to people they knew than were men.

Kessler and McLeod (1985) suggested, however, that it was not the actual use of those social resources that reduced the level of stress, but simply the perception that those resources were available and could be accessed, and the emotional support provided by the social contacts was sufficient to buffer the effects of environmental demands.

Thoits (1982) also emphasised the social, rather than the psychological resources available to an individual, and suggested that the changes typically measured in life events scales reflect “gains and losses of supportive relationships” (p. 148) rather than measuring strictly change. She argued that the changes measured by most scales reflect changes in social support more than they do a pure "change score" event. Although she focused on specific life events that directly alter social relationships such as divorce and death of a spouse, she argued that any significant life change will have an effect on social relationships and other aspects of an individual's life. According to Thoits, life change scores confound the direct effects of life events on support and the interactive or buffering effects of life events with support.

Seeman and Anderson (1983) also emphasised the social resources that buffer the effects of stressful life events. However, they found that social support networks were associated with behaviours frequently connected with psychological distress, which may also indicate confounding of independent and dependent variable measures. The results of their study were equivocal, because they found that a personal sense of powerlessness and the lack of a sense of control is associated with problem drinking, as is high social involvement.

Turner and Avison (1992) discussed the link between stressful life events and an individual's ability to cope. They attempted to estimate the individual's sense of mastery and the impact of the burden of stress experienced. They interpreted the differential impact of stressors in terms of Erikson’s crisis theory: good experiences are positive and enabling while negative experiences reduce the individual's ability to cope with stressful life events. This approach implies that a large number of positive outcomes will teach a child to anticipate success, and failures will teach a child to anticipate failure. Furthermore, positive outcomes will decrease the impact of subsequent stressors. They found that "successful resolution appears to buffer the impact of events because such resolution constitutes a personally meaningful positive experience that counterbalances substantially the stress associated with the event" (p. 48).

Turner and Marino (1994) argued that the differences in mental health are a result of differences in social support. They found that the level of perceived social support varied systematically across gender, marital status, age categories and occupational level, and that the level of perceived social support was negatively related to the level of psychological distress. The one exception to the pattern was among women, who had the highest level of perceived support as well as the highest level of psychological distress. Turner and Marino argued that:

1. the effect of social support on psychological distress is independent of the level of stress;
2. support is more important if the stress level is high; and
3. these are moderated by stress exposure and across subgroups of the population.

According to this study, the perception of the existence of social support resources was more important than the actual experience of receiving social support.

Leo Srole (1956) proposed an alternative way of conceptualising the individual's view of the social environment based on Durkheim's concept of anomie. Srole developed a tool to measure the degree of alienation and powerlessness felt by the individual, designed to measure a "molecular view of individuals as they are integrated in the total action fields of their interpersonal relationships and reference groups" (p. 710.) According to Srole, "the immediate analytical objective would be to place individuals on an eunomia - anomia continuum representing variations in interpersonal integration with their particular social fields as 'global entities' ..referring to the individual's generalised, pervasive sense of 'self-to-others belongingness' at one extreme compared with 'self-to-others distance' and 'self-to-others alienation' at the other pole of the continuum." As such, the scale that he developed included an assessment of the individual's perceived support network, and perceptions of social pressures. Srole argued that the scale also considered forces at a somewhat personally distant remove – his scale was more inclusive than measuring the individual's direct relationships – and included reference groups beyond the immediate field of action, generalised qualities of the molar society as these affect the individuals' life choices and goals, and the childhood socialisation processes as they affect the individuals expectations, orientations and behaviour.

Srole focused on the individual and the individual traits that made him or her anomic. He was not as concerned with the problems of society at the societal level, but rather the inability of the individual to relate properly to the society. There are five dimensions of anomia:

1. The community leaders are insensitive to individual needs;
2. The social order is unpredictable;
3. People are retrogressing from previously established goals;
4. Life is meaningless;
5. Personal relationships are not supportive or predictable.

Anomia expresses the malintegration or dysfunctional relationship between individual and social world; an anomic individual will appear alienated from the political system (item 1), the cultural system (item 2), the economic system (item 3), the internalised social norms and values (item 4) and the primary socialisation group (item 5). "Srole acknowledges that individual anomia can be explained by social anomie, but points out that the opposite causal link is also significant, as psychological anomia feeds back to social anomie" (Orru, 1987:127). However, Srole's scale changed the focus from the social structure (and consequently the implied 'fixing' of the social structure to remedy the issue) to the psychological condition of the individual's attitude and his or her relationship with others.

Despite the popularity of the scale (it was included in the General Social Survey for many years), Travis (1993) questioned the validity of Srole's scale, pointing out that it has very low test-retest reliability, and poor internal validity. Travis proposed an alternative scale for measuring alienation, but his scale has a significant number of problems, including an overlap between some of the questions and the more common measures of sub-clinical depression. Travis's Margins of Society scale was also not widely adopted.

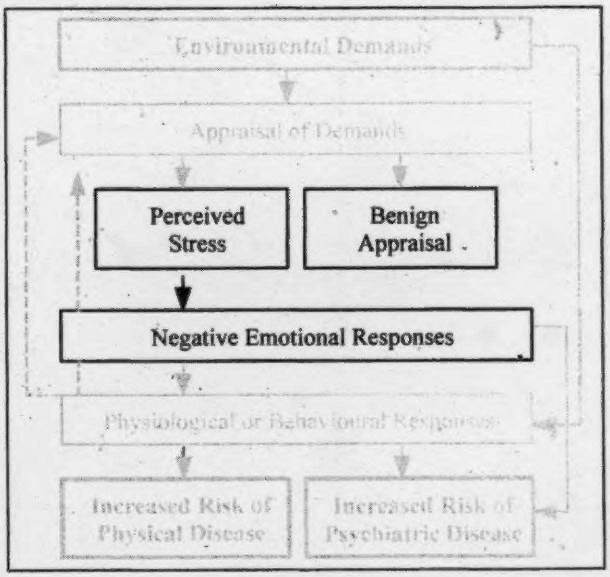
To date, very little success has been achieved in defining the social structural causes of disease. We know from basic epidemiological studies that, for example, men suffer more heart attacks than women, but it is still unclear if the underlying cause is genetic structure, social structure, or personality and emotional response to events.

The current analysis includes an exploration of the two aspects of appraisal of demands: psychological resources and social resources, using measures developed specifically for the analysis. According to Pearlin, Kessler, Turner and others, the individual considers the available resources in the appraisal process, and the belief in the availability of these resources mediates the effect of external or environmental stressors on the health of the individual. The individual's belief in the availability of these resources is a key component of the evaluation of the stress process and it is necessary to include these measures in an application of the full model to determine if external events have an effect on diagnosis that is independent of the various coping strategies that an individual might bring to bear.

Although significant to the understanding of the stress process, an evaluation of the psychological processes that individuals use to evaluate a given situation (the appraisal processes outlined by Lazarus) were considered outside the scope of the current analysis.

PERCEIVED STRESS, BENIGN APPRAISAL AND NEGATIVE EMOTIONAL RESPONSE

We have considered the development of measures of environmental demands intended to measure the first step of Cohen, Kessler and Gordon's model and have also considered the methods developed to measure the second step on Cohen's model: of appraisal of resources that could be leveraged


Environmental Demands
Appraisal of Demands
Perceived Stress
Benign Appraisal
Negative Emotional Responses
Physiological or Behavioural Responses
Increased Risk of Physical Disease
Increased Risk of Psychiatric Disease

to reduce the impact of an environmental demand. Next we need to understand the literature that has developed to measure the individual's perception of the situation. According to Cohen's model, the outcome of the individual's cognitive appraisal of the event is a perception that the event is stressful or a perception that the event is benign. If an individual perceives that the event is stressful, they will respond by becoming more aroused, in order to mobilise as many resources as required to reduce the stress. This corresponds to Selye's alarm stages of response to stress. Responding with anger or frustration corresponds to Selye's resistance stage of stress, and depression is a response that would correspond to Selye's exhaustion stage.

As mentioned above, the development of measures of stressful events was primarily focused on measurement of the elements of the social structure that affect individual health, but they also frequently confounded the measures by including measures of the impact of the events on the individual, or the level of arousal that the individual felt as a result of the external pressures from the social environment. Furthermore, much of the work by Pearlin and others to develop measures of coping and appraisal strategies used a measure of arousal as the dependent variable (in the form of questions about how stressed the individual felt). Pearlin's questionnaire has become one of the most popular measures of the stress response – so much so that it is perhaps becoming over-used and no longer useful as a measurement tool.

In order to understand Selye's alarm stage and the role of arousal in the response to environmental demands, it is necessary first to understand emotional response and how it might relate to arousal.

In an attempt to understand how positive life events might precipitate a schizophrenic episode, Brown and Harris (1978) noted that a model of affect and its relationship to the experience of stress is crucial to the definition of how stress might exert an influence on physical or psychological health. Brown and Harris referred to Tomkins' model of affect as defining the relationship between affect and stress, suggesting that life events should be viewed in terms of the emotions they might arouse, and that it is arousal that leads to a stress response.

Although Tomkins (1962) focused on demonstrating that the physiological response precedes the experience of emotions and did not address the issues of stress, he considered the affect system to be the primary motivational system that amplifies any other state, particularly drive states of the organism. As the primary motivating system, an emotional response to an event would stimulate the organism to respond with a coping or avoidance strategy. Tomkins defined emotions as being either positive or negative, and argued that all emotions can be characterised by the density of neural firing:

1. Increased neural firing coincides with emotions such as startle, fear and interest;
2. Level neural firing coincides with emotions such as anger or distress (distress is an absolute level of density of neural firing in excess of the optimal, that is, steady but higher than normal); and
3. Decreased neural firing coincides with emotions such as joy and laughter.

Tomkins argued that some emotions are primary, and that other emotions are a combination of the primary emotions. According to Tomkins, many emotions require cognitive appraisal, but equally as many do not. It is unclear what role cognition plays in emotion according to Tomkins, but the distinction is not important to his theory. The key to Tomkins' argument is that neural firing changes in response to an event and neural firing can change as a result of cognition, memory, perceptual or motor responses.

The model of emotions and how they are experienced led to further exploration of emotions and the potential relationship between emotional experience and arousal. For example, Russell (1980) proposed that affect is best represented as a circle in two-dimensional space that contains two bi-polar dimensions: pleasure-displeasure, and degree of arousal. This two dimensional representation is commonly termed a *circumplex model*. The circumplex model, developed by Guttman[2], is a factor analysis technique that positions the individual emotions, moods or traits in a circle relative to each other. According to Wiggins (1973), a circumplex model can be described as follows: "adjacent variables in a matrix should be more highly correlated than nonadjacent variables and the degree of correlation between any two variables should be a direct function of their distance from each other on the circle." The basis of a circumplex model is that it should be possible to demonstrate the existence of a circumplex by factor analysis of the intercorrelation matrix and plotting the loading of all variables on orthogonal axes representing the first two factors. The location of all variables should form an approximate circle under these conditions.

Russell compared the circumplex model with a rating technique where he asked participants to place the emotions in the correct location and found a very similar circular pattern of relationships. Furthermore, Russell found the same circular pattern in different languages, showing consistency across cultures. Russell also compared self-report data (considered to reveal the structures of actual affective experience) with judgement data (considered to yield semantic structures rather than actual experience) and found that the resulting models defined similar circumplex structures. Russell argued that other researchers use factor analysis to include the factors that should really be excluded and that is why they arrive at models that describe five or more dimensions. Russell argued that the most informative structure is a model that describes "both the layman's cognitive structure for affect and for the actual structure of affective experience" (p. 1176).

---

[2] Guttman L; 1954. A General Nonmetric Technique for Finding the Smallest Co-ordinate Space for a Configuration of Points, *Psychometrika*, 33(4):469-506. Guttman defined circumplex as a model that depicts 'a circular ordering of variables, based on their degree of similarity. It refers to the geometric implications of an intercorrelation matrix in which the correlations among variables systematically range from high positive through zero to high negative."

Conte and Plutchik (1981) also attempted to use several different methods to validate the circumplex model. They used 223 trait terms and conducted two separate studies: a paired comparison of the terms and a semantic differential evaluation of 40 of the terms. The goal of the study was to define the structure of personality traits, or how personality traits are related to one another, and whether personality traits or situational factors are the main determinants of behaviour.

According to Conte and Plutchik, an emotion has 5 components:

1. the stimulus or event;
2. the cognition of the event;
3. assessment of feeling;
4. behaviour guided by innate mechanisms and the assessment; and
5. the function served by the behaviour.

Although they support the circumplex model of emotions, they also argue that there are eight basic emotions (sadness, fear, surprise, anger, disgust, anticipation, joy and acceptance or sexual receptivity) and that all emotions are one of the eight or a combination thereof.

Although a general model of emotions does not bear directly on the relationship between stressful events and health outcomes, it does provide a theoretical basis for development of tools to measure arousal and thereby include arousal as a variable in the evaluation of the model. According to Selye's model discussed earlier, an emotional response to an external event would be associated with a prolonged or elevated general biophysical response, which in turn would result in an adverse effect on health. Many studies have either attempted to incorporate arousal into the measures of events (such as a measure of the individual's perception of the significance of the event), or have confounded it with the measure of the outcome (such as depression, which can be considered to be a low level of arousal plus an expression of negative affect or valence), but seldom has it been separately identified and measured as a component of the stress-health outcome model.

As early as 1975, Mason argued that the one common element in the stress process is the physiological response to emotional arousal, but measuring the differences in physiological response to different emotional states has proven difficult. In an early review of the literature on the after-effects of stress, Cohen (1980) outlined a variety of tests that had been used to measure arousal in the stress-outcome process, but he demonstrated that the literature focused on experimental techniques, rather than testing the entire model in the population. He argued at that time that there was very little evidence of the impact of arousal on the immediate after-effects in an experimental situation, but it was also clear that the measures of arousal were less than ideal and not sufficient for application in a non-experimental situation.

The knowledge of the physical systemic responses and methods to measure them has developed slowly, and even though Ekman, Levenson and Friesen (1983) identified minute differences in physiological response to different emotions, the identification of physical responses to emotional changes is far from complete. Ekman et al measured only heart rate and change in body temperature, but they did find that the type of emotion experienced stimulated a different amount of change in each dimension measured: anger and fear resulted in similar changes in heart rate, but different changes in temperature.

Jemmot and Locke (1984) reviewed a number of studies of the association between stress and changes in the functioning of the immune system, but pointed out that there is no clear understanding of what that actually means, because (with the exception of specific disease groups) the link between immune system dysfunction and disease is not clearly understood.

Rahe (1988) also argued in support of the importance of arousal in the stress process model, and emphasised that it is the amount of anxiety felt, rather than the amount of change *per se* which is the key factor in the stress process. He suggested that the link between stress and illness is the anxiety arising as a consequence of life stresses that are greater than that with which the individual is able to cope, filtered by the individual through a cognitive assessment of the resources available. In Rahe's model, an individual may experience physiological changes in response to a stressful life event of which he or she is entirely unaware.

As discussed above, Russell's circumplex model of emotions indicates that emotion has two dimensions, which he labelled as arousal and valence (other researchers labelled as positive and negative value of the emotion). If measured as a total of all emotions, arousal corresponds quite closely to Selye's alarm stage response. However, there is no evidence in the literature that this dimension has been considered as an indicator of the emotional response to environmental demands.

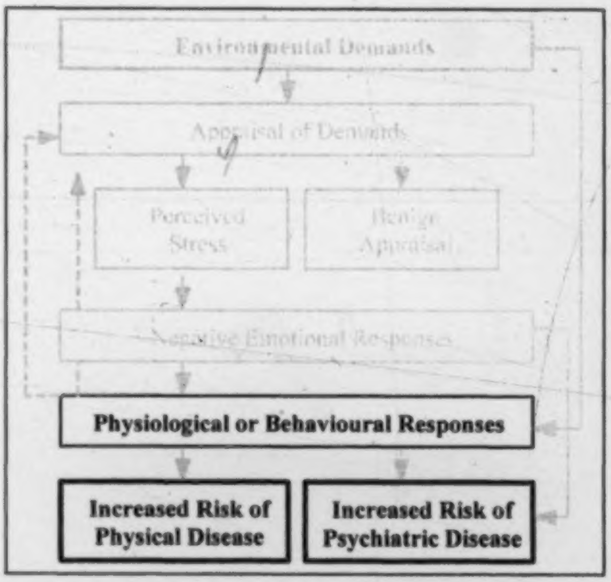
Valence, on the other hand, more closely corresponds to the negative emotional responses identified in Cohen, Kessler and Gordon's model. Understanding and incorporating these two measures into an analysis of the stress process is critically dependent upon the theory of emotions outlined above, which has been largely missing from the sociological literature. Although few studies have focused on the role that arousal plays in the stress process, the vast majority of both sociological and psychological studies have used negative affect (as opposed to clinically diagnosed depression) as an outcome variable. However, according to Cohen's model, the expression of negative emotions falls only midway through the process, and does not necessarily indicate an adverse health outcome.

Level of arousal and the ability to express or moderate emotions has been associated with personality characteristics frequently associated with some disease categories. For example, Eysenk (2000) suggests the cancer-prone personality is one who represses emotions, finds it difficult to deal with stress, gives up easily and develops feelings of helplessness and hopelessness. He also replicated the study that identified a relationship between a Type A personality and coronary heart disease originally conducted by Friedman and Rosenman (1954, 1974) in 1990, demonstrating that people who are prone to 'neurotic excesses' are more likely to develop diseases such as coronary heart disease and cancer. More recently, a variety of researchers have focused on the association between the predominance of specific negative emotional responses and specific health outcomes, such as the association between anger and coronary heart disease (Chang, et al, 2002). In a prospective study of men, Chang, Ford, Meoni, Wang and Klag found that anger was related to premature coronary heart disease (CHD) and myocardial infarction (MI) for men younger than 55 years of age. Similar results were found by Williams, Nieto, Sanford and Tyroler (2001) who evaluated both men and women for anger temperament or trait, and found increased risk of both CHD and MI. Associations have also been identified between anger or hostility and recurrent headache (Venable, Carlson, and Wilson, 2001), and suicidal ideation in adolescents (Miros, 2000). However, in all these studies it is unclear whether the influencing factor is the level of arousal felt by the individual, or if the anger, as negative emotional response, results in specific physiological changes responsible for altering health outcome.

This literature provides some key new directions in the analysis of the stress process that have not been broadly explored to date. In addition to measures of self-reported stress and negative emotional responses, the current analysis explores the association between arousal and the stress process, and tests the hypothesis that arousal can be used as a measure of Selye's alarm stage. As we saw above, a significant body of research has been published that describes emotions and the association between emotions, but this has not been applied to the evaluation of the stress process, despite the observations by Brown and Harris (1978), Rahe (1988) and Eysenk (2000) that it is the expression or repression of emotions and the amount of anxiety felt that is the key factor in the stress process.

Physiological or Behavioural Responses and Increased Risk of Disease

The last components in the model reflect the physiological outcomes of the stress process. As mentioned above, a number of attempts have been made to measure physiological response, but researchers have met with very little success. The review of the literature on measurement of physiological changes was considered out of scope for this analysis because these changes were not measured, and were also considered outside the area of knowledge of the researcher.


Environmental Demands
Appraisal of Demands
Perceived Stress
Benign Appraisal
Negative Emotional Responses
Physiological or Behavioural Responses
Increased Risk of Physical Disease
Increased Risk of Psychiatric Disease

A variety of approaches to measurement of disease have been applied in the literature, but most researchers rely on retrospective or concurrent data collection methods so the causal direction is unclear (Suls, Wan, and Blanchard, 1994). Alternatively, researchers use self reported measures of diagnosis, which have problems of validity and accuracy (Desai, Bruce, Desai & Druss; 2001).

Measurement of health outcome or diagnosis determined by the individual's physician at the time when the individual presented the symptoms is considered the 'gold standard' for measurement of health conditions, because the coding is done by highly trained evaluators (physicians). Furthermore, research comparing physician billing information with other measures of diagnosis which ask the respondent what their diagnosis was found that the physician billing information significantly more reliable and accurate, even when the diagnosis is as specific and salient as cancer (Desai, Bruce, Desai & Druss; 2001).

SUMMARY

The earliest research into the impact of stress on health focused on developing tools to measure those events that might have a significant relationship, but the focus quickly shifted to an evaluation of the social and (primarily) psychological mechanisms through which stress operated. A variety of tools have been developed to measure a full range of environmental demands including major and minor stressors, chronic strains and lifetime traumas, and a number of tools have been developed to measure the social and psychological processes that mediate both the psychological and the physiological responses. The association between stressful environmental demands and stomach ulcers represented a striking success and popularised the study of the impact of stress on health. However, the study of stress and of methods for reducing stress enjoyed only a brief heyday period before the discovery of H. Pylori, the bacteria responsible for stomach ulcers, cast research into stress and disease into a disfavour from which it has been unable to recover. Researchers continue to debate whether there is any association at all, and some researchers have even argued that the results in the literature are all spurious (Smith, D, 2001) while others continue to argue in support of development of new approaches to the research (Levenstein, S, 1998).

Although researchers, primarily in the field of medicine, continue to evaluate the association between events and some select health diagnoses, very little advancement has been made in the field for several years, with the exception of the identification of the association between anger and heart health. The effort to try to find evidence to support or refute Selye's original findings has not been significant, although there has been some renewed interest in trying to replicate his studies. The identification and measurement of a non-specific response could lead to significant improvements in the understanding of the etiology of disease.

The current analysis was developed using Cohen, Kessler and Gordon's model to define the various components of the process, and uses a combination of retrospective and prospective approaches to data collection, to address the concerns in the literature around causal priority (Sul et al, 1994; Whitehead, 1994). The review of the literature suggested that the current study should include more than one type of measure of environmental demands. Therefore the current study includes a selection of the measures developed by Holmes and Rahe, which requires the respondent to report on events that occurred in the previous year, as well as Brantley's (in Zalaquett and Wood, 1997) weekly stress inventory which also requires the respondent to report on events that happened in the more recent past. These measures were well defined in the literature and supported by a significant body of research, and the inclusion of the two different types of measures addresses the concerns of the proponents of each method. Although Brown and Harris argued that positive events did not have an effect on the stress process, measures of positive events were included to assess that argument.

The literature on measurement of the appraisal component of the stress process can be divided into two realms, based on the intended goal of the study. The first group of studies seeks to identify the psychological processes involved in the appraisal process, and the second seeks to understand and quantify the assets that the individual assesses as part of the appraisal process. The current study focuses more on the evaluation of the outcomes of the stress process, and the psychological processes involved in the appraisal process were considered outside the scope. Therefore, the measures of appraisal focus on the social and psychological demands and resources available to the individual similar to the approach taken by other researchers including Pearlin (1989) and Srole (1956), rather than measuring the processes involved in appraisal. The measure of psychological resources is similar to the measures developed by Pearlin, although Pearlin's questions were not used. Srole's measures of anomia are also well documented in the literature, and have been used extensively for a variety of other research topics, but have not been applied to the stress process model. A new measure of social resources was developed for the study, and although there was no evidence in the literature that other researchers had considered this type of measure, it fits well with the theoretical model of the stress process outlined by Cohen, Kessler and Gordon (1997) and the outline of the appraisal process proposed by Lazarus and Folkman (1984).

Pearlin (1989) suggested that simply asking the individual if they feel stressed is an appropriate measure of stress, so this type of measure was included in the current study. In fact, a basic measure of self-reported stress level is commonly used in stress research, and is frequently included in large scale social studies such as the community health surveys conduct by Statistics Canada[3].

The literature does not evaluate Selye's three phases of the General Adaptation Syndrome, so measures of the three phases are not readily available. While the current analysis used Cohen, Kessler and Gordon's stress process model as a guide to define the measures, the focus of the analysis was to evaluate the original stress process model defined by Selye, so a measure of the alarm stage was a necessary addition. Although the measure of emotions was developed by Bradburn (1969), and has been used by other researchers (Gillespie 2001) to measure arousal as a dimension of emotion, it has not been evaluated as a part of the stress process in the stress literature. The concept of arousal is, however, theoretically aligned with Selye's alarm stage of response to stress.

Cohen, Kessler and Gordon's model of the stress process indicates the need for a measure of negative emotional response, and the research in the literature uses negative emotional response as both a dependent variable (Thoits, 1995) and as an independent variable (Chang et al, 2002). However, for the purposes of the current study, the measures of negative emotional response are considered to be midway through the stress process, rather than the beginning or the outcome of the process, and reflect the individual's emotional response at the time of the study.

---

[3] For example, see http://stcwww.statcan.ca/english/sdds/3828.htm, 2004

CHAPTER 3: METHODS

STUDY DESIGN

As mentioned previously, Thoits (1995) argued that much of the literature has focused on using only a single indicator of health outcome, and most frequently that indicator is a measure of sub-clinical depression or other psychological impairment, which confounds the analysis because the measurement of the dependent variable often overlaps with the measures of the independent variables. Focusing on a single outcome measure does not address the fundamental question of whether the physiological response to stressful environmental demands is non-specific, nor does it allow for clear delineation of the relative importance of any of the specific components of the overall model. The evaluation discussed below uses a broad range of health conditions to support analysis of the potential impact of events and emotional responses on health outcomes, and includes measures of each stage of Cohen, Kessler and Gordon's model, to ensure that the impact of each component is adequately measured and considered. The model was tested using a number of health conditions which have been associated with stress in the literature, such as Type 2 diabetes and coronary heart disease, as well as a variety of other health conditions.

HYPOTHESIS AND RESEARCH QUESTIONS

As mentioned above, the objective of this study is to determine whether the response to external events or stressors can be characterised as a general non-specific response, or if the response to external stressors only results in specific disease categories. A second objective is to determine the importance of the social and psychological responses in the stress process and whether external stressors have a direct impact on health, or if the effect on health is only caused by ineffective social and psychological responses to external stressors.

Two secondary objectives were: to evaluate the viability of measuring the stress response using a measure of arousal; and to evaluate the significance of the individual's perception of society as supportive or harmful in the stress process.

The analysis evaluates the stress process using the heuristic model described by Cohen, Kessler and Gordon, which is widely accepted, and enables a holistic approach to the evaluation. The specific research questions to be considered are:

1. Can the response to external events be characterised as non-specific? That is, do the external environmental demands affect a wide variety of diagnoses, independently of the social or psychological mediators in Cohen's model?
2. Can the stress response (Selye's alarm stage) be measured?
3. What is the relative significance of the social and psychological mediators in the model? and
4. How do the social and psychological responses to stressful events affect health outcomes?

Selye's model argues that there is a non-specific physiological response to all environmental demands. Cohen, Kessler and Gordon's model and the existing literature argue a much more complex process where an individual appraises the impact of an external event in light of the personal and social resources available, and becomes aroused if the appraisal process determines that there are not sufficient resources to mediate the threat. According to Eysenk and others, those individuals who are more likely to express anger (a specific type of arousal) will have an increased risk of cardiovascular system diseases but not other diseases, such as diabetes. It is unclear from Eysenk's description of the 'cancer-prone' personality type whether that individual would be more likely to exhibit anxiety or to suppress emotions, but both models will be considered by the analysis.

The hypotheses to be tested by the analysis are that:

1. external demands result in a non-specific physiological response, independent of the social or psychological resources available to the individual;
2. level of arousal is an indicator of the level of stress and is associated with an increased risk of diagnosis, and is the final measure in the causal chain from environmental demand, through appraisal and evaluation to arousal as a response;
3. belief in the availability of social and psychological resources mediates the non-specific physiological response and affects the development of specific disease types; and
4. the individual's lack of a sense of connection to the social environment and belief in society as hostile increases the risk of development of disease.

OPERATIONALIZING THE HYPOTHESES

There are a number of difficulties with measuring the existence of a non-specific response, and as was briefly discussed in the review of the literature, most attempts to define and measure the minuscule physiological changes associated with a non-specific response identified by Selye have not been successful. Consequently, in addition to measuring the eosinophil count identified by Selye's studies, the study discussed below required a definition of a non-specific response that could be tested. Using information about diagnoses is restrictive, because the act of identifying and recording a diagnosis means that the individual's physiological response has already resolved into a specific manifestation of disease. However, it could be argued that finding significant causal associations between environmental demands or events and a number of different health conditions could be considered as implying a non-specific physiological response to the arousal that has subsequently resolved into specific diagnoses as a result of other moderating factors, particularly if the sample is representative, and all possible diagnoses are considered by the analysis. On the other hand, if environmental demands are only associated with one or two different diagnostic categories such as those widely accepted in the literature, that implies that the response to environmental demands results only in specific physiological changes, possibly through the expression of a specific emotion. Therefore, the test of the first hypothesis above should find evidence that the measures of environmental demands are directly associated with a variety of diagnoses across a number of different biophysical systems. Furthermore, if environmental demands are only associated with a diagnosis through a social or psychological mediator, that implies that the relevance of the environmental demand is of secondary importance.

The second hypothesis focuses on the measurement of the stress response. The most frequently used measure of stress has become part of modern nomenclature, and because of the social status accorded to someone who is 'under a lot of stress', may no longer be a valid measurement tool. Consequently, the analysis will evaluate level of arousal, and test the hypothesis that it is a more accurate and objective indicator of the level of stress, and that this measure is associated with an increased risk of diagnosis whereas the standard measure of stress is unassociated with any measure of health outcome.

The third hypothesis above stated that belief in the availability of social and psychological resources mediates the non-specific physiological response and affects the development of specific disease types. In order to confirm the validity of this hypothesis, the analysis would have to find evidence that the measure of psychological resources is one link in the causal chain leading to some specific diagnoses but not others, and the same should be true for the measures of social resources, including length of stay in the community, and amount of social contact.

The final hypothesis to be tested by the analysis also focuses on a measurement tool. Most research into the individual's sense of belonging to the community has not been particularly successful at identifying elements of the social environment that affect the individual's ability to cope with environmental demands. The proposed tool focuses on the individual's lack of a sense of connection to the social environment and belief in society as hostile as a parallel to Pearlin's psychological measure of mastery. This tool will be tested to determine if these beliefs also increase the risk of development of disease.

ANALYSIS

The analysis was conducted in phases, first to evaluate the correlations between the measures to identify zero order relationships between the variables in the model, followed by structural equation modelling to evaluate the research questions identified above. Factor analysis was used to validate the development of scales, and regression and structural equation modelling techniques to determine the significance of components of the larger model. Correlation analysis was used to screen variables from the model that were clearly unrelated to the other measures in the model.

Structural equation modelling (SEM) was used to evaluate the complete model because it has a number of benefits for this type of research. SEM offers a more effective method for measuring latent variables because it incorporates a variety of statistical procedures into the analysis simultaneously, including factor analysis and multiple regression. The factor analysis component provides the functionality of identifying latent variables using observed exogenous measures and considers these factors as endogenous variables, rather than relying on the less exact method of combining the exogenous variables into an index. SEM analysis provides the most effective method of using a set of questions to measure two different latent variables (valence and arousal). Without SEM techniques, the use of scales would require that the items are balanced in order for the balance of positive over negative and total affect to provide relatively pure measures of valence and arousal.

At the same time, SEM enables evaluation of the causal relationship between these latent variables and the other variables in the model. SEM also provides the ability to specifically control for random and systematic measurement error in the model.

DATA SOURCES

The data for the analysis were obtained from a study conducted in three communities in northern Alberta to assess personal exposure to airborne contaminants. Although the original study was designed to evaluate the health effects of exposure to airborne contaminants, the protocol was developed with the consideration of the entire disease process and included measures of potential confounding or alternative causes of illness. Recognition of the processes outlined in Cohen, Kessler and Gordon's model was a key factor in determining the scope and content of the data collection instruments. The study was conducted in three separate communities over a five year period. Several measures were added to the survey instrument for the second and third communities, but the protocol was not otherwise altered, and the minimum standard questionnaire was administered to all respondents.

The first community was a medium-sized community of 36,400 people (March 1999 City Census) established as a by-product of the development of the oil sands industry. This community, referred to hereafter as Oiltown is a relatively isolated community, located in the middle of a forested area largely designated for wood products, adjacent to large oil sands operations, and approximately 280 miles from the nearest metropolitan centre. The study data were collected during 1997 and 1998.

According to the 2002 Official Population List (Alberta Municipal Affairs, 2002), the second city is about the same size at 36,983 people, and although it is located at an approximately parallel latitude, is less isolated due to the larger rural population in the surrounding areas. This community also has a more diverse economy, including agriculture, oil and gas extraction and processing and a large wood product and pulp industry. This community will be referred to as Pulptown. The study data for Pulptown were collected in 2000.

The third community, hereafter referred to as Rivertown, is a smaller community at only 13,121 people, but is located only minutes from a large urban centre. The study data for Rivertown were collected in 2001.

Both the Pulptown and the Rivertown samples included people from the surrounding rural areas, but the Oiltown sample was restricted to urban residents for logistical reasons.

Due to the significant burden of participation in the study (multiple questionnaires, carrying personal air quality samplers, and providing blood and urine samples and a week of time commitment), the sampling was not conducted using a standard random probability sampling approach. Instead, a sampling pool of volunteers was recruited from each community using a variety of print media, phone solicitation, and recruitment of staff from major employers. Volunteers were required to be residents of the area and older than 18 years of age to qualify for placement in the sampling pool. All respondents for the study were then selected from the pool of volunteers, and were chosen to reflect the local population distributions of age and gender.

The study protocol included administration of a questionnaire to assess exposure to stressful events and physical and psychological health at the time of the study. Questionnaires were provided to the respondents during an initial interview, and retrieved from the respondent a week later. Identification of a chronic health diagnosis was included in the survey questionnaire, and this self-reported diagnosis was used as a predictor in the analysis. Health conditions were identified through physician diagnoses extracted from provincial healthcare billing records obtained subsequent to the initial data collection period. Health care billing records were obtained for the year prior to and several years following the collection of the survey information, which were used to identify health conditions which developed after the study period. However, the analysis restricted the health conditions to those that developed within a one year period following the data collection period, to ensure comparability across communities. In addition, if a respondent had received a diagnosis in the year prior to the study, the diagnosis was not included as an outcome measures, to ensure that only new diagnoses (which was not diagnosed prior to the data collection period) were included. This approach to study design ensures that the measures reflect the full scope of the stress process and the necessary time lag between exposure to events, evaluation of the social and psychological resources, and the development of adverse health outcomes.

Respondents were required to provide signed consent to allow the researcher to link study survey results with physician billing records, and only those respondents who provided signed consent are included in the analysis. Confidentiality was maintained throughout the course of the study by removing all reference to the individual and data was linked through the use of individually assigned numbers[4]. There are a total of 558 respondents in the combined sample used for the analysis, consisting of 222 males and 336 females.

RELIABILITY OF MEASURES

Only those measures that were widely used and evaluated that had already been demonstrated as reliable and valid were included in the study. The questions used in the questionnaire were all taken from well established sources. The measures of health outcome or diagnosis were determined by the individual's physician at the time when the individual presented the symptoms. This source of data has been considered a 'gold standard, because the coding is done by highly trained evaluators, and in comparisons with other measures of diagnosis which ask the respondent, is deemed considerably more accurate, even when the diagnosis is as specific and salient as cancer (Desai, Bruce, Desai & Druss; 2001).

---

[4] For further description of the study protocols, see Health Surveillance, 2000. *Alberta Oil Sands Community Exposure and Health Effects Assessment Program: Methods Report.* Alberta Health and Wellness.

Although income has been identified as a key factor in the development or alleviate of a condition of stress, the current analysis does not include a measure of income because the indicator that was used for the study was not able to discriminate sufficiently between high and low income respondents.

SAMPLE CHARACTERISTICS

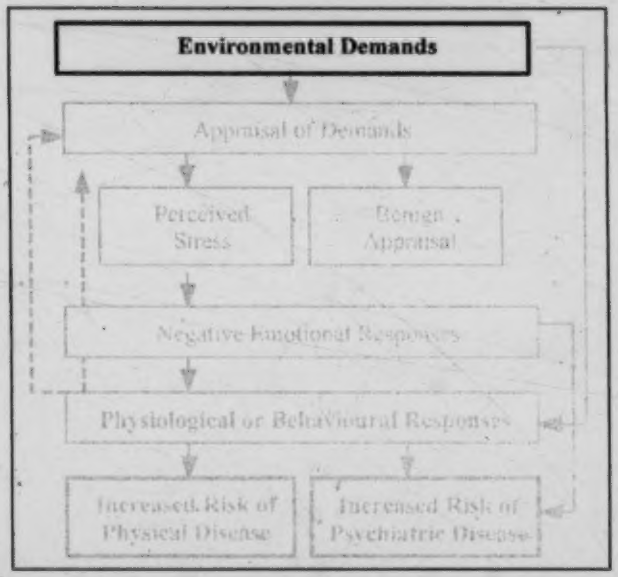
The mean age for the total sample was 42.85 (S.D.=11.24), and the average number of years of education was 14.5 (S.D.=3.3). Analysis comparing the study sample populations with the total population of each community indicated that the sample populations were similar in distribution for age, gender and education, but had a slightly higher income[5]. The average length of stay in the respective community was 13.88 years (S.D.=9.99).

MEASURING ENVIRONMENTAL DEMANDS

The first process in the model is environmental demands – the individual is exposed to stressful events and other external demands. Environmental demands for the purposes of this study includes both event stressors (major and weekly stressors) as well as other pre-existing 'risk' factors, such as gender, age, education, body mass index, activity level and the existence of a previously diagnosed chronic disease. These factors all place demands on the individual that might exacerbate the individual's level of stress, and subsequently their health.

---

[5] Health Surveillance, 2000. *Alberta Oil Sands Community Exposure and Health Effects Assessment Program: Technical Report.* Alberta Health and Wellness.


Environmental Demands
Appraisal of Demands
Perceived Stress
Benign Appraisal
Negative Emotional Responses
Physiological or Behavioural Responses
Increased Risk of Physical Disease
Increased Risk of Psychiatric Disease

As discussed above, there is no clear agreement on the correct method of measuring events, so measures of two different types of events were included: the major life events defined by Holmes and Rahe, and the weekly stress inventory developed by Brantley. There was no reason to consider a specific list of major life events tailored to the sample characteristics, because the sample is representative of the general population, and therefore should be exposed to the major life events with the same frequency as the total population.

Sample Characteristics

Age at the time of the study was coded as a continuous variable. Gender was coded for the purposes of the analysis as a dummy variable, with male coded as one and female coded as zero. Community was also coded as a dummy variable, with the first community (Oiltown) coded as one and the other communities coded as zero, so that the analysis considers the residents of the Oiltown community in comparison with the other respondents. Dummy variables for each of the other two communities were considered in the preliminary analysis, but discarded because there was no difference between the two communities. The preliminary analysis also confirmed the perception that the Oiltown community is qualitatively different from the other two communities because of it's isolation, the impact of the economic expansion just beginning at the time of the study period, and the difference in the population distribution (the community draws a large number of itinerant workers from other parts of the world because of the oil sands development activities).

Healthy Behaviours and Chronic Diseases

Risk factors are another type of environmental demand. The risk factors included in the analysis include body mass index, activity level and pre-existing diagnosis of a chronic disease. Both physical activity level and body weight have been associated with health outcomes, and are therefore a necessary component of any analysis of health outcomes. Previous diagnosis of a chronic disease also affects the development of new diagnoses, and identifies individuals who have pre-existing health problems likely to be more prone to the effects of stress.

The Body Mass Index (BMI) is a widely accepted measure of obesity and it correlates well with other measures of body weight such as body density. A body mass index is a calculated measure comparing the individual's weight and height, which can be used to indicate both under- and overweight. A body mass index of between 20 and 25 is considered in the healthy range, 25 to 27 indicates the individual is slightly overweight, and over 27 indicates obesity. A BMI score under 20 also indicates a health risk, but in this case the individual is underweight for their height. The mean value for body mass index for the sample was 27.2 (S.D. = 5.16), indicating that the sample is slightly overweight.

Activity level is also a calculated measure which represents the average minutes of activity per week in which the individual took part, and includes a very wide variety of activities from walking and gardening to tennis and other organised sports. Respondents were asked to indicate how many times they had participated in each activity in the previous three month period, and the duration of participation each time. The average amount of time that each individual participated in all combined physical activities was calculated from these scores. Higher scores in the analysis represent higher levels of activity.

A standard survey instrument was used to identify previously diagnosed chronic conditions. The frequency and percentage of the population who reported receiving a previous diagnosis of a variety of chronic diseases is shown in Table 1. These diagnoses are pre-existing conditions, and act as independent conditions that may affect health outcomes through the additional stress caused by chronic illnesses.

The existence of each diagnosis was identified and a measure of the total number of chronic diseases was used for the analysis, based on the assumption that each additional chronic condition not only predisposes the individual to additional co-morbidity, but also that each additional disease diagnosis would increase the overall impact of external stressors.

Table 1: Self-Reported Chronic Diseases

Diagnosis	Frequency	Percentage
Food allergies	76	13.9
Other allergies	177	32.5
Asthma	85	15.6
Chronic bronchitis or emphysema	22	4.0
Sinusitis	79	14.5
Arthritis	100	18.3
Back problems, excluding arthritis	144	26.4
Diabetes	18	3.3
Epilepsy	7	1.3
High blood pressure	64	11.7
Heart disease	10	1.8
Effects of stroke	5	0.9
Cancer	18	3.3
Alcoholism	7	1.3
Urinary incontinence	16	2.9
Kidney failure or kidney disease	5	0.9
Acne requiring prescription medication	41	7.5
Cataracts	7	1.3
Glaucoma	2	0.4
Migraine headaches	66	12.1
Head injury	30	5.5
Emotional illness	30	5.5
Mental health condition	21	3.9
Nervous system disease	12	2.2

Major Life Events

A selection of the events originally developed by Holmes and Rahe were administered in all three communities. Two problems could arise from an inadequate selection of events: none of the respondents experienced the event; or all of the respondents experienced the event. Either distribution would significantly impair any subsequent analysis. Table 2 shows the percentage of the sample who had experienced each of the events in the year prior to the study interval. Each event was experienced by at least twelve respondents, and some were experienced by a large proportion of the sample.

Typically, studies evaluating the relationship between stressful events and health outcomes use a measure of the total number of all life events to determine if there is a cumulative impact of events on health outcomes. This approach assumes that the total number of life events creates a general feeling of turmoil in one's life, and that the effects are cumulative. Using a cumulative scale also accounts for a broad range of events, assuming that not all people will experience all events and thereby makes the measurement tool replicable across populations. Analysis typically has also included separately evaluating the effects of positive and negative events to determine whether positive events have a positive or buffering effect on health outcomes.

Table 2: Frequency of Experience of Major Events

Event	Number	Percentage
Lost job or been unemployed	53	9.7
Work-related difficulties	83	15.1
Got married	12	2.2
Separated or divorced	22	4.0
Quit or retired	23	4.2
Illness or injury	42	7.7
Death of someone close	128	23.4
Trouble with spouse	49	8.9
Improvement in finances	136	24.8
Strike or laid off	12	2.2
Financial problems	112	20.4
Arrival of baby	18	3.3
Someone moved in or out	134	24.5
Started working or changed jobs	130	23.7
Illness or injury of someone close	80	14.6
Changed residence	98	17.9
Promotion at work	55	10.0

The weighting schemes developed by Holmes and Rahe and others, using the model developed by Ross and Mirowsky (1979), were applied to the Alberta sample for the basic correlation analysis to determine the value of weighting the measures and to identify the most parsimonious measure. Table 3 shows the mean value obtained by applying each of the weighting schemes. The simple additive scale results from counting the total number of events. The Simple Desirability Scale is calculated by counting the total number of desirable events, and the Simple Undesirability Scale is a count of the number of undesirable events. The Holmes Rahe Weighting Scale applies the weights defined by Holmes and Rahe to each event, and the Hough Weighting Scale uses the new weights defined by Hough. These two weighting schemes attempt to incorporate the relative amount of change caused by each event into the overall scale score. The Hough weighting scheme results in significantly higher scores compared to the other schemes, but this is consistent across all respondents. Finally, the Difference Score Scale subtracts the number of positive events from the number of negative events, based on the argument that the positive events will have a positive effect, and will reduce the overall impact of the negative events.

Table 3: Mean Weighting Score for Events Scales

Weighting Technique	Mean	SD
Simple Additive	2.17	1.809
Simple Desirability	.82	1.009
Simple Undesirability	1.06	1.232
Holmes Rahe Weighting	85.12	73.703
Hough Weighting	233.31	225.989
Difference Score	-0.24	1.494

Weekly Stress Inventory

The review of the literature suggested that the analysis should not rely entirely on measurement of major life events, but should also consider an alternative method of evaluating events as well. Brantley's Weekly Stress Inventory (WSI) was added to the survey instruments for Pulptown and Rivertown (N=243). Brantley's WSI asks respondents to identify whether or not each of 84 events occurred in the past week, and how much stress the respondent felt as a result, using a 7-point Likert scale where 1 is not stressful and 7 is extremely stressful. The mean frequency of experiencing the 84 events in the list for the respondents in the two communities was 25.64 (S.D. 13.26), and the mean estimated level of stress caused by the experience was 193.90 (S.D. 805.35). Table 4 shows the mean response for each measure.

Table 4: Measures of Weekly Stress Inventory

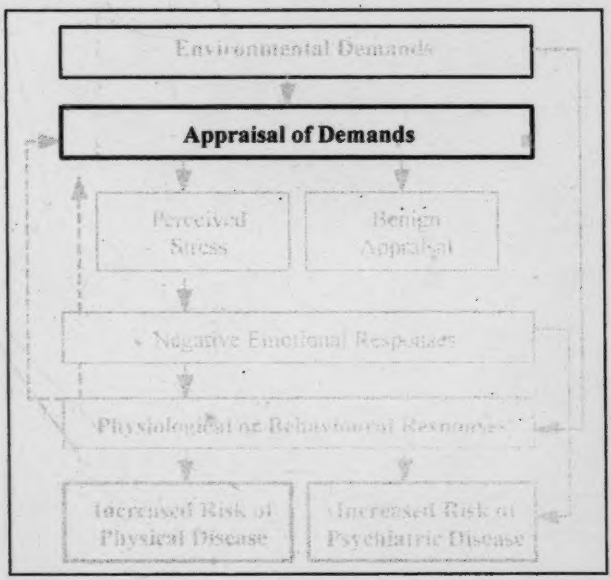
Stressor	Event was Stressful		Event Occurred	
	Mean	S.D.	Mean	S.D.
Assignment overdue	1.82	10.978	.21	.405
Red tape	3.12	14.039	.36	.480
Argued with co-worker	1.70	10.978	.16	.372
Hard time from clients	1.70	10.952	.22	.414
Did poorly at job	1.74	10.964	.19	.396
Hurried to meet deadline	3.33	13.996	.47	.500
Interrupted during task	2.98	10.875	.73	.446
Someone spoiled task	2.02	12.623	.15	.360
Did something not good at	3.43	15.302	.44	.497
Unable to finish task	2.09	8.992	.49	.501
Unable to finish all plans	1.90	6.465	.59	.492
Late for appointment	2.69	14.041	.31	.463
Evaluated for performance	1.99	12.621	.15	.360
Worked late	2.90	14.018	.45	.498
Not enough money for basics	2.56	14.085	.16	.364
Ran out of money	2.27	12.637	.21	.405
Unexpected bills	1.84	10.978	.23	.419
Problems paying bills	2.58	14.078	.19	.393
Not enough money for fun	2.76	14.056	.28	.452
Problem obtaining transportation	1.39	10.959	.09	.282
Drove under bad conditions	1.75	10.966	.23	.419

Stressor	Event was Stressful		Event Occurred	
	Mean	S.D.	Mean	S.D.
Car trouble	1.35	9.008	.21	.408
Minor auto accident	1.24	10.955	.02	.142
Argued with significant other	2.23	9.036	.48	.501
Child misbehaved	3.40	15.319	.39	.489
Child had school problems	3.11	16.577	.12	.320
Minor illness of significant other	2.83	15.367	.19	.396
Spouse had problems at work	2.61	14.060	.24	.430
Not enough time for family	3.16	14.005	.45	.499
Crime in neighbourhood	1.94	12.630	.12	.325
Had household chores	2.52	8.892	.92	.275
Had minor home repairs	2.00	10.922	.49	.501
Problems with neighbours	1.04	8.983	.10	.299
Ran out of food	1.48	10.964	.13	.339
Property damaged	1.40	10.970	.07	.262
Store didn't have something	2.00	12.600	.26	.439
Problems with pet	1.88	10.972	.28	.450
Heard rumour about self	1.79	12.624	.08	.269
Was told what to do	2.61	12.562	.52	.501
Was lied to	1.98	10.998	.25	.435
Was misunderstood	3.38	15.321	.40	.491
Confrontation with authority	2.22	14.088	.07	.256
Criticised or verbally attacked	1.93	10.988	.23	.425
Around unpleasant people	1.88	10.976	.24	.430
Unexpected guests	2.02	12.601	.27	.444
Did poorly because of others	1.37	10.961	.07	.249
Forced to socialize	1.61	10.952	.22	.414
Someone broke a promise	1.60	10.983	.12	.330
Competed with someone	1.88	12.608	.18	.382
Argued with a friend	1.81	12.628	.08	.269
Not enough time to socialize	2.36	12.588	.36	.482
Ignored by others	2.02	12.616	.19	.389
Had someone disagree	2.77	12.561	.55	.498
Spoke in public	1.79	10.950	.30	.461
Interrupted while talking	2.67	12.556	.60	.490
Was stared at	2.83	15.353	.28	.450
Someone cut into line	1.89	12.606	.20	.399
Unable to express self clearly	3.12	13.988	.53	.500
Had unwanted physical contact	2.01	12.612	.19	.389
Dealt with rude waiter etc	1.95	12.618	.16	.364
Was without privacy	2.03	12.611	.22	.414
Was excluded or left out	1.99	12.619	.16	.368
Had too many responsibilities	2.95	12.575	.49	.501
Had to make important decision	3.37	13.988	.58	.495
Did not hear from someone	2.17	12.617	.24	.430
Was disturbed trying to sleep	2.52	10.956	.48	.501
Forgot something	4.40	16.391	.78	.417
Heard bad news	1.95	9.028	.42	.494
Was clumsy	2.76	14.032	.39	.489
Lost something	2.23	10.951	.44	.498
Had legal problems	1.71	12.623	.05	.208
Waited longer than wanted	2.56	12.574	.45	.498

Stressor	Event was Stressful		Event Occurred	
	Mean	S.D.	Mean	S.D.
Did something didn't want to do	1.83	8.982	.47	.500
Had to face feared situation	1.49	9.024	.24	.427
Had pet peeve violated	2.64	14.049	.28	.450
Failed to understand	2.50	12.574	.48	.501
Had close escape	1.79	12.625	.07	.249
Had minor accident	1.84	12.615	.13	.334
Someone borrowed without asking	1.81	12.619	.10	.299
Had minor injury	2.11	12.607	.26	.437
Was physically uncomfortable	2.39	12.578	.44	.498
Stopped unwanted habit	2.28	14.077	.11	.315
Interrupted while relaxing	2.64	12.555	.57	.496
Not enough time for fun	3.04	14.007	.47	.500
Did poorly at sport or game	1.93	12.614	.16	.372
Saw upsetting TV show etc	2.75	14.053	.32	.466
WSI stressfulness	193.9	805.34		
WSI count			25.6	13.26

MEASURING THE ABILITY TO ADAPT

The second process in the model is the appraisal of the demands to determine if the environmental demands pose a threat, and whether the individual believes he or she has access to enough resources to cope with the demand (shown highlighted in black in the diagram at the right). The analysis conducted for this study did not include measures of the appraisal process (that is, *how* the individual evaluated the demands), but focused instead on the measures of the psychological and social resources the individual believes they have at their disposal.


Environmental Demands
Appraisal of Demands
Perceived Stress
Benign Appraisal
Negative Emotional Responses
Physiological or Behavioral Responses
Increased Risk of Physical Disease
Increased Risk of Psychiatric Disease

Psychological Resources

The psychological resources included in the analysis reflect those developed by Pearlin (1978) including mastery, self-denigration and self-esteem. Table 5 shows the questions which were selected from a standard questionnaire because they correspond most closely to the measures developed by Pearlin, and shows the percentage of participants who responded to each indicator. The questions were administered as part of the General Health Questionnaire, developed by Goldberg (1972) as a self-administered screening tool for identifying diagnosable psychiatric disorders. Although the entire General Health Questionnaire scale has very good reliability, preliminary factor analysis of the chosen items indicated that the seven measures had good reliability as a separate scale measuring self-perceived efficacy (α=.8252).

Table 5: Measures of Psychological Resources

Question	Possible Responses			
Felt on the whole you were doing things well?	Better than most	About the same	Less well than usual	Much less than usual
	13.4	77.2	8.7	0.7
Felt that you are playing a useful part in things?	More so than usual	Same as usual	Less useful than usual	Much less useful
	11.5	77.0	10.2	1.3
Felt capable of making decisions about things?	More so than usual	Same as usual	Less so than usual	Much less capable
	10.8	81.6	7.1	0.6
been finding life a struggle all the time?	Not at all	No more than usual	Rather more than usual	Much more than usual
	42.4	45.7	9.6	2.2
been losing confidence in yourself?	Not at all	No more than usual	Rather more than usual	Much more than usual
	53.0	35.6	9.8	1.7
been thinking of yourself as a worthless person?	Not at all	No more than usual	Rather more than usual	Much more than usual
	75.8	19.7	3.5	0.9
felt that life is entirely hopeless?	Not at all	No more than usual	Rather more than usual	Much more than usual
	82.3	14.6	2.6	0.6

The majority of the respondents indicated high self-efficacy, but the distribution does indicate that a number of the respondents expressed feelings of poor self-efficacy, sufficient for analysis of the association of this dimension with health outcomes. For the purposes of the analysis, a high score represents low belief in psychological resources.

Social Resources

Three measures of social resources were included in the analysis: social contact, anomia/alienation and social disconnection. One of the most commonly studied social resources is social support. Measures of the social resources available to the individual used for this analysis include measures of social support and stability in the community. Table 6 shows the percentage of the sample who indicated they had contact with others, and the type and frequency of contact. One community in which the studies were conducted (Oiltown) is a relatively isolated northern community, which affects the frequency with which the residents are able to visit with relatives. Pulptown and Rivertown are less isolated. Despite the fact that the distribution for the Oiltown respondents may not be representative of other less isolated communities, it is still a relatively normal distribution when all three communities are combined.

Table 6: Measures of Social Contact

	Never %	Almost never %	Less than once a month %	Once a month %	Several times a month %	Several times a week %	Almost daily %	Daily %
Contact neighbours for a chat	8.3	16.4	13.6	10.1	30.2	13.4	5.9	2.0
Visit friends in town	1.5	7.9	10.7	16.6	43.4	14.0	4.1	1.8
Visit relatives in town	29.6	9.3	10.0	9.5	26.6	10.8	3.7	0.6
Contact friends out of town	1.8	5.4	14.9	17.9	37.5	15.9	4.1	2.6
Contact relatives out of town	0.7	3.7	9.0	12.7	45.4	20.5	5.4	2.6

The second measure of the individual's social resources included in the analysis is anomia and alienation. This measure uses the anomia questions developed by Srole to measure a sense of disconnection to society he called 'anomia', and also includes the questions designed to measure alienation, taken as a whole from the NORC General Social Survey and altered slightly to reflect Canadian content (see Table 7). The scale has a reliability of α=0.8870. Factor analysis of all the measures indicated that 40% of the variance is explained by the first component (Eigen value=5.998), and only an additional 10% of the variance could be defined by defining a second component. All of the measures, with the exception of question 7, had a high loading on the first component. This is likely due to the double-barrelled nature of the question, which confuses the importance of health with that of the importance of money. None of the questions were excluded from the analysis.

Table 7: Measures of Anomia and Alienation

Question	Percentage of Responses						
	Disagree						Agree
1. The people running this country don't really care what happens to you.	4.7	11.5	17.3	23.5	24.0	11.2	7.8
2. The rich get richer and the poor get poorer.	1.9	4.5	9.5	16.8	25.5	24.6	17.3
3. What you think doesn't count very much anymore.	6.7	20.6	19.9	24.0	20.0	4.5	4.3
4. You're left out of things going on around you.	15.0	31.2	23.7	16.2	9.2	3.0	1.7
5. Most people with power try to take advantage of people like yourself.	8.6	25.5	20.6	20.6	14.4	7.1	3.2
6. The people in Ottawa are out of touch with the rest of the country.	2.2	8.6	16.9	15.4	25.1	17.0	14.8
7. Next to health, money is the most important thing in life.	31.2	24.1	16.8	11.4	7.3	5.6	3.6
8. You sometimes can't help wondering whether anything is worthwhile anymore.	39.1	27.0	9.2	11.6	7.9	3.0	2.2
9. To make money, there are no right and wrong ways, only easy and hard ways.	48.3	22.2	8.6	10.5	3.8	4.3	2.3
10. Nowadays, a person has to live pretty much for today and let tomorrow take care of itself.	30.1	22.1	18.1	11.6	8.2	6.0	3.9

Question	Percentage of Responses						
	Disagree						Agree
11. In spite of what some people say, the lot (situation/ condition) of the average person is getting worse, not better.	10.1	15.5	19.3	21.7	19.3	8.8	5.2
12. It's hardly fair to bring a child into the world with the way things look in the future.	32.1	21.9	15.3	13.1	7.7	6.2	3.7
13. Most public officials (people in public office) are not really interested in the problems of the average person.	5.2	15.5	20.7	20.6	18.3	12.1	7.5
14. These days a person doesn't really know whom can be counted on.	10.8	22.1	18.1	19.1	19.8	6.0	4.1
15. Most people don't really care what happens to anyone else.	16.4	29.9	20.6	13.5	12.5	4.3	2,8

The third measure of social resources was developed to reflect a measure of the individual's sense of mastery and control over their social environment as a parallel to the measure of the individual's assessment of their sense of personal mastery. The scale consists of four measures (see Table 8) taken from a study by Gartrell and Krahn (1983) to evaluate satisfaction with community life tested in one of the same communities several years prior to the current study. The questions were selected because they reflect a belief in lack of control over the social environment, of a sense of being powerless in the social sphere of the community. This measure reflects the individual's sense of being marginalized, independent of their socio-economic status or other more common measures of marginalization.

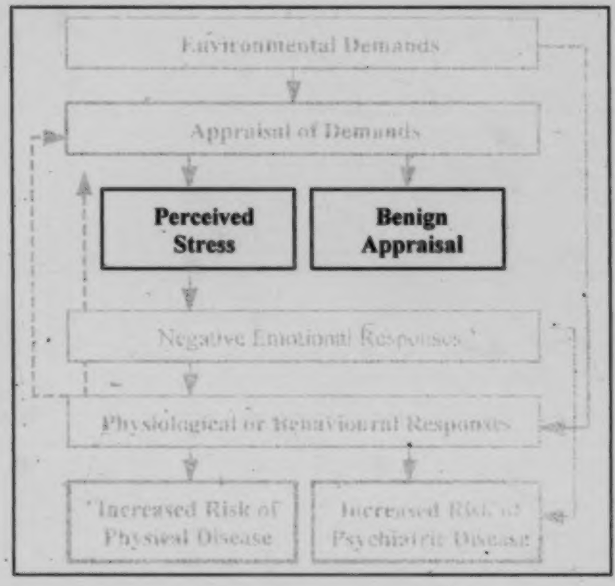
Exploratory factor analysis was conducted using all the questions in Gartrell and Krahn's scale to determine if the questions could be used to measure a single dimension. The four negative measures were recoded in the opposite direction prior to analysis. The factor analysis indicated two separate dimensions, based on the positive or negative tone of the questions (identified by the – or + sign in the first column). The first dimension (consisting of the positively worded items 2, 3, 4, 5, 9, 10, 11 and 12) was considered for use in the model and eliminated because it was not significantly correlated with any of the other measures in the model. The second dimension, measured by the negatively worded questions 1, 6, 7, and 8 in Table 8, indicate a belief that the individual is powerless against the general social forces of the community. The scale reliability of this measure was only .5804, but it was included in the analysis and labelled 'social disconnection' because it was significantly correlated with a number of other measures in the model.

Table 8: Measures of Social Disconnection

Question wording:		Strongly Disagree					Strongly Agree	
		1	2	3	4	5	6	7
-	1. Overall, political-economic control of my town rests in the hands of a few prominent business people.	4.0	8.1	12.3	20.7	25.3	18.2	11.0
+	2. The provincial government has really helped my town's development.	3.3	7.0	15.5	29.4	24.8	15.5	4.4
+	3. The municipal government is interested in my needs and cares about my opinion.	6.8	7.2	14.2	30.2	29.7	10.1	1.8
+	4. If I have a concern with municipal bylaws, I can call and get action.	4.6	10.3	15.5	26.8	26.4	12.7	3.7
+	5. Local officials are really accessible in my town.	2.4	3.0	10.3	24.4	28.0	24.1	7.8
-	6. Social class is important in my town.	5.5	10.7	13.7	25.1	19.9	16.2	8.9
-	7. Family breakdown is common in my town.	3.0	4.1	10.0	23.3	18.5	21.8	19.4
-	8. The local industries are responsible for a lot of pollution in my town.	3.7	6.3	8.9	14.1	19.7	23.7	23.6
+	9. Pollution is better controlled than it used to be.	3.8	5.7	5.7	14.0	24.7	33.1	12.9
+	10. The local industries have reduced their pollution emissions in the past few years.	4.4	6.1	7.1	18.1	25.9	24.2	14.2
+	11. The local industries care about environmental damage and are actively working to reduce long-term impacts.	5.9	6.5	7.4	16.9	26.7	25.8	10.8
+	12. The Regional Health Authority (RHA) Board is interested in my health/welfare.	3.1	4.6	4.6	19.9	30.2	26.7	10.9

The length of stay in the community and the number of people in the household were also used to represent social contact and therefore the social support resources available to the individual. The assumption for using length of stay as a measure of social contact is that the longer the length of stay in a community, the more likely that the individual will meet more people, will become more integrated into the community and will learn more about what values are important to the community. The measure of the number of people in the household assumes that more people in the household increases the opportunities for social contact and for alternative methods of alleviating the stressful environmental demand.

MEASURING SELF-PERCEIVED STRESS


Environmental Demands
Appraisal of Demands
Perceived Stress
Benign Appraisal
Negative Emotional Responses
Physiological or Behavioural Responses
Increased Risk of Physical Disease
Increased Risk of Psychiatric Disease

The next step in the stress process according to the model is the perception that the situation is stressful or benign (shown in black in the diagram at the right). The analysis did not include a separate measure of benign appraisal, but focused instead on measuring perceived stress. The measure most frequently used in the literature[6], asks the respondent to define how much stress they feel or the 'usual' level of stress in their life. The frequency of responses to this question are shown in Table 9. One of the concerns with this measure is that, to feel stress requires a level of commitment to the social roles one occupies, and variation in the level of commitment affects the validity of the measure. Another concern with this measure is that, although the distribution is normal, a large proportion of the sample (more than half the sample) believe that their life is somewhat stressful, indicating that the scale is not able to discriminate very well between different qualitative levels of stress. For the purposes of the analysis, this measure was coded so that high values represent high stress level.

---

[6] For example, see http://stcwww.statcan.ca/english/sdds/3828.htm , 2004

Table 9: Frequency of Response to Self-Perceived Stress

Descriptor	Frequency	Percentage
Very stressful	61	11.2
Somewhat stressful	320	58.6
Not very stressful	142	26.0
Not stressful at all	23	4.2

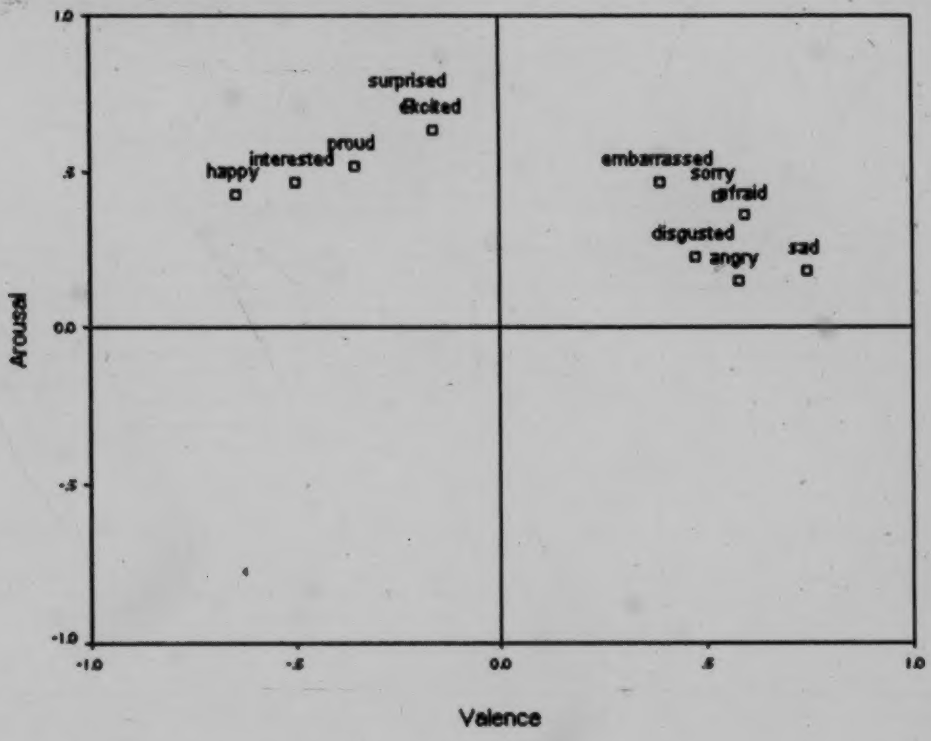
Another way of conceptualising self-perceived stress hinted at in the literature review is to estimate the emotional volatility of the individual. This method of measurement more closely approximates the alarm stage reaction discussed by Selye. The measure of arousal used for this study reflects the emotional volatility of the individual, and uses the Discrete Emotions Scale developed by Carroll Izard (1971). The items are scored on a 4-point scale indicating frequency of experiencing the emotion in the past few weeks. Arousal is calculated as the frequency of experiencing emotions, regardless of the type of emotions. The percentage of respondents indicating the frequency with which they experienced each emotion is presented in Table 10.

Table 10: Percentage and Average Experience of Emotions in Previous Few Weeks

Emotion	Never %	Rarely %	Sometimes %	Often %	Mean
Angry	5.8	39.9	47.9	6.5	1.55
Excited	2.8	23.5	61.7	12.0	1.83
Disgusted	18.5	43.6	33.8	4.1	1.23
Proud	3.3	15.4	58.7	22.6	2.01
Afraid	33.5	48.0	17.3	1.3	0.86
Sad	11.9	44.1	37.5	6.5	1.39
Interested	0.7	3.5	50.0	45.7	2.41
Surprised	6.5	32.8	54.9	5.8	1.60
Sorry	8.3	41.1	47.8	2.8	1.45
Happy	0.4	4.7	43.2	51.8	2.46
Embarrassed	14.4	55.9	28.7	0.9	1.16

Exploratory factor analysis was conducted on the eleven emotion items to determine if the two dimensions of valence and arousal could be identified. Figure 2 is a factor plot of the loadings from an unrotated solution. The top part of the figure is consistent with a circumplex interpretation, but the bottom two quadrants are empty. The mean level of arousal in the sample was 17.97 (S.D. = 3.4) and the range was between 7 and 28.

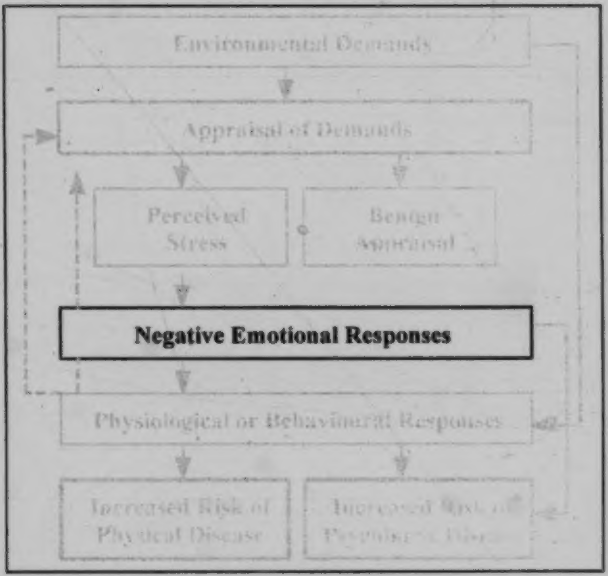
Figure 2: Component Plot for Emotion Items



Specifically including measures of self-perceived stress and arousal in the analysis supports an evaluation of the impact of events on emotional arousal, and of events and arousal separately on health outcomes. Furthermore, defining arousal and self-perceived stress as separate dimensions will support identification of the relative utility of each measure in the model.

MEASURING NEGATIVE EMOTIONAL RESPONSE

The next step in the process according to the model is the development and expression of negative emotional responses (shown in black in the diagram at right). These negative emotional responses can include expression of depressive symptoms, symptoms of tension, or increased feelings of anger.


Environmental Demands
Appraisal of Demands
Perceived Stress
Benign Appraisal
Negative Emotional Responses
Physiological or Behavioural Responses
Increased Risk of Physical Disease
Increased Risk of

Several measures of negative emotional response were included in the analysis. The first measure (valence) was calculated from the emotion scale discussed above. The emotion scale scores were combined for the initial correlation analysis using two different calculation methods to reflect valence (negative emotions subtracted from positive emotions) and arousal (sum of all frequency values), according to a strategy developed by Bradburn (1969). Valence is therefore a measure of the balance of positive emotions, or what could be termed 'happiness'. The mean level of valence recorded for the sample was 1.09 (S.D. = 1.9) and the range was between –6.0 and 4.0. Higher values represent more positive emotions.

The second method of measuring negative emotional responses used a scale from the Profile of Mood States developed by McNair et al (1971) and adapted for use by Letz (1996) in a computerised application called the Neurobehavioral Evaluation System 2.

The questionnaire includes 25 different emotions or moods, and asks the respondent to indicate how frequently the 'feeling' was experienced in the previous week. Five different mood profiles are calculated by the application, each using the responses to five items which are summed to create the mood profile score. The frequency of experiencing each feeling is shown in Table 11, as well as the mean value of the mood scale composite scores that were used for this analysis. The coding for three measures (relaxed, calm and happy) is reversed for the calculation of the respective scales. Although not as robust as the tests used by Cheng et al (2002), this group of measures nonetheless identifies individuals whose emotional responses are predominantly anger, depression or tension. High values represent greater expression of anger, tension or depression.

By using different measures of the dimensions of emotion to assess both the emotional arousal and the expression of negative emotional responses, the analysis can compare the relative importance of general states of arousal or anxiety with the predominance of specific emotions in the development of certain conditions, such as anger with heart disease.

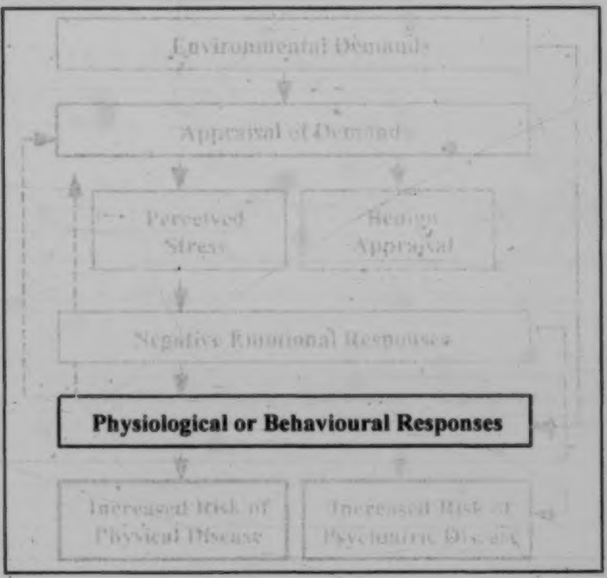
Table 11: Measures of Anger, Depression and Tension

Measure	not at all %	a little %	moderately %	quite a bit %	extremely %
Anger Mood Profile (mean=1.7, S.D.=.544)					
Angry	31.4	52.4	12.1	4.0	0.0
Grouchy	31.1	56.1	10.5	2.3	0.0
Annoyed	23.0	55.9	15.8	4.8	0.5
Furious	77.4	17.5	4.2	1.0	0.0
Bad-tempered	58.4	35.3	5.7	0.7	0.0
Tension Mood Profile (mean=2.3, S.D.=.674)					
Tense	17.0	44.6	24.8	12.0	1.7
On edge	33.6	50.1	11.5	4.2	0.7
Relaxed *	4.2	20.8	41.3	28.6	5.2
Nervous	52.7	35.3	8.0	3.5	0.5
Calm *	4.7	16.1	34.6	38.1	6.5
Depression Mood Profile (mean=1.8, S.D.=.642)					
Unhappy	37.1	49.1	7.5	4.5	0.8
Sad	42.8	43.1	9.5	3.2	1.5
Miserable	69.8	22.1	4.2	2.0	0.2
Gloomy	64.2	26.6	5.3	3.5	0.3
Happy *	2.0	10.0	33.8	45.8	8.5

MEASUREMENT OF PHYSIOLOGICAL RESPONSE

The next step in the process according to Cohen, Kessler and Gordon's model is the development of physiological and behavioural responses (shown in black in the diagram at the right).

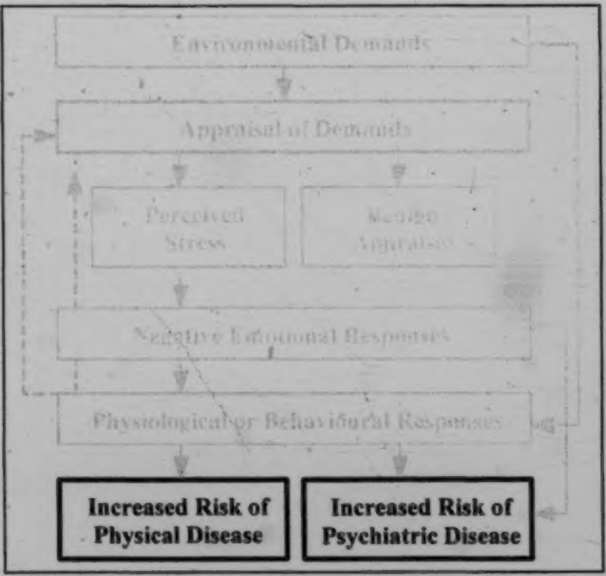
Two measures of physiological response were included to measure the non-


Environmental Demands
Appraisal of Demand
Perceived Stress
Benign Appraisal
Negative Emotional Responses
Physiological or Behavioural Responses
Increased Risk of Physical Disease
Increased Risk of Psychiatric Disease

specific response to environmental demands: IgG and eosinophil cell count. The IgG measures an elevated response of the immune system; the eosinophil cell count was one identified by Selye in his experiments on animals. Both measures are obtained from blood samples and are very reliable measures obtained from the medical laboratory in each community. Elevated IgG levels were found to be associated with allergic response to pollens[7], and all eosinophil levels were within the normal expected range[8]. Preliminary analysis of the correlations between eosinophil level and the measures of the stress process as well as the diagnosis found no significant associations, with the exception of a significant correlation with previous diagnosis of a chronic disease. Consequently, these two indicators were not considered for further analysis.

MEASUREMENT OF HEALTH CONDITIONS

The final step in the stress process according to the model is the development of physical or psychiatric disease (shown in black in the diagram at the right). As mentioned above, the social psychological literature has focused


Environmental Demands
Appraisal of Demands
Perceived Stress
Benign Appraisal
Negative Emotional Responses
Physiological or Behavioural Responses
Increased Risk of Physical Disease
Increased Risk of Psychiatric Disease

---

[7] Health Surveillance, 2002. *Alberta Oil Sands Community Exposure and Health Effects Assessment Program: Technical Report.* Alberta Health and Wellness.

[8] Health Surveillance, 2002. *The Grande Prairie Community Exposure and Health Effects Assessment Program.* Alberta Health and Wellness.

on sub-clinical depression as an outcome measure, and on the social-psychological mechanisms through which stress becomes manifest. Meanwhile, the medical literature has focused on identifying which diagnoses might be associated with stress, often assuming that the social psychological model is valid and simply measuring the respondent's self-perception of stress or focusing on the measurement of events and the associated health outcomes, ignoring the social and psychological processes.

The analysis of the entire model, however, requires measurement of each stage in the process to be effective, so the analysis described below included many of the outcome measures used by other researchers, including self-perceived stress levels, and sub-clinical depression, but also included a measure of a health condition diagnosed by a physician. Illnesses and conditions that developed after the study period were identified through physician billing records. Diagnoses made by a physician were restricted to new diagnoses, or diagnoses for which the respondent did not visit a physician during the year prior to the interview period. Diagnoses are recorded using the ICD-9-CM classification, which can be used to identify very specific diagnoses, such as asthma or bronchitis, or can be grouped to reflect general classifications of diseases, such as respiratory disorders. The use of physician diagnoses enables the analysis to focus only on those conditions that developed subsequent to the initial data collection period to ensure that the dependent variable (health condition) does not precede the events or independent variables (e.g. events, social and psychological appraisals) in time.

The percentage of the sample who were diagnosed with a new condition during the year following the study period is shown in Table 12. A separate analysis compared the frequency of diagnosis of the sample population to the frequency of diagnosis of the rest of the population in the respective communities and found that there was no difference in diagnosis patterns[9].

Table 12: New Physician Diagnoses by Category

Diagnosis	Percentage
Neoplasms (140-208)	10.3%
Breast (174)	2.2%
Endocrine/Immune Disorders (240-279)	12.4%
Diabetes (250)	2.1%
Blood Diseases (280-289)	5.0%
Mental Disorders (290-319)	16.7%
Nervous System Diseases (320-389)	10.5%
Circulatory System Diseases (390-459)	11.9%
Ischemic heart disease (410-414)	3.8%
Cardiac dysrhythmias (427-428)	6.2%
Cerebrovascular disease (430-438)	1.5%
Hypertension (401-405)	6.2%
Pulmonary disorder (415-417)	0.3%
Arteries and capillaries (440-448)	1.0%
Respiratory System Diseases (460-519)	7.6%
Pneumonia/Influenza (480-487)	6.9%
Chronic bronchitis (490-493)	5.7%
Other chronic obstruction (COPD) (496)	0.5%
Digestive System Disorders (520-579)	13.3%
Stomach disorder (531-537)	4.6%
Genitourinary System Disorders (580-629)	9.6%
Complications of Pregnancy (630-650, 652-676)	2.4%
Skin Diseases (680-709)	12.6%
Diseases of Musculoskeletal System (710-739)	11.2%
Ill-Defined Conditions (780-799)	5.0%
Injury (800-959)	6.5%
Other conditions (V and E codes)	10.5%

Restricting the analysis to only new diagnoses that developed after the initial study collection period has two implications for the analysis. The first implication is that the analysis underestimates the association between stress and disease because the analysis would consider respondents who have a pre-existing condition as falling in the same category as respondents who did not have any condition, even though these respondents may have the same levels of stress and social-psychological resources as respondents who are diagnosed with a condition subsequent to the study period. Any significant associations found between stressors and diagnosis is all the more significant, given this caveat for the analysis.

---

[9] Health Surveillance, 2000. *Alberta Oil Sands Community Exposure and Health Effects Assessment Program: Technical Report.* Alberta Health and Wellness.

The second implication of this approach to the data is that evaluation of the impact of psychological and social resources on exacerbating existing health problems is not possible. However, this analysis was considered out of scope for the current analysis.

CHAPTER 4: CORRELATION ANALYSIS

The initial phase of the analysis included a review of the frequency of responses to each measure primarily used to validate the completeness of the responses (shown in Chapter 3). The next step in the analysis was to evaluate the measures typically used in the sociological and psychological literature to evaluate the effects of stress on the appraisal process and the subsequent expression of negative emotional responses and symptoms of sub-clinical depression. The correlation analysis was also used to remove variables that are clearly unassociated with the outcome variables prior to specifying the model. If a zero-order relationship can not be demonstrated between the independent and dependant variables, it is unlikely that the variables would be associated through a mediating variable[10]. Therefore, evaluation of the correlation analysis provides a simple method of reducing the number of unassociated variables from the model. In all discussion of the associations below, only those which are significantly correlated with each other will be mentioned or discussed (where $p<.01$ or $p<.05$).

ENVIRONMENTAL DEMANDS

As discussed above, environmental demands are defined for the purposes of this analysis to include all the characteristics of the sample which could be considered risk factors in the development of disease, as well as measures of major life events and the weekly stress inventory. The first step in the correlation analysis, therefore, is to assess the association between each of these risk factors and the subsequent measures of appraisal, perceived stress, and negative emotional response, represented by the arrows in the diagram at the right.

---

[10] There is a possibility that that a mediating variable is acting as a suppressor, affecting both the independent and dependent variable with opposite signs, that more than one mediating variable is offsetting the indirect effects, or that the is pernicious interaction in which the effect is positive for one group but negative for another. However, although these are technically possible, they are not very likely because they require a precise balance of opposite causal forces.

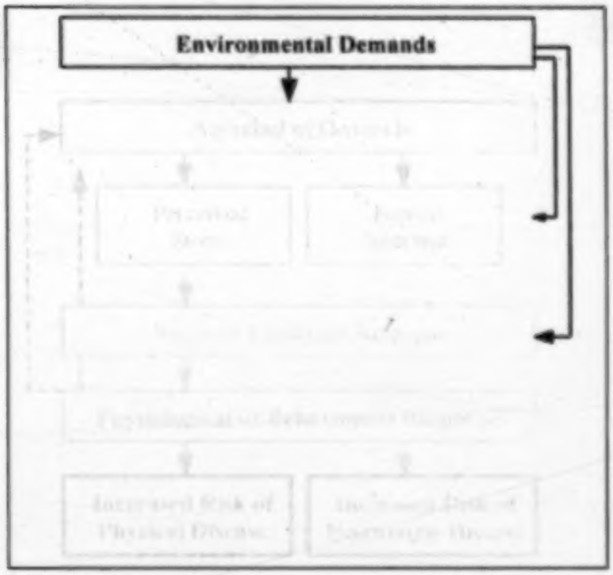

Environmental Demands
Appraisal of Demands
Perceived Stress
Physiological or Behavioral Response
Increased Risk of Physical Disease
Increased Risk of Psychiatric Disease

Table 13 shows the significant correlations between community (where the responses from the first community "Oiltown" were compared to the responses from the other communities) and the measures of the subsequent processes in the model. There was a larger proportion of males (.108) in the sample from Oiltown, and the sample was younger as well (-.187). Respondents in Oiltown had more years of education (.172), and were less likely to have a chronic disease diagnosis (-.143) at the time of the study. Respondents in the Oiltown community was also more likely to experience two specific events (getting a promotion at work (.140) and having someone move in or out of the house (.127)), and with one of the event scales (the simple additive scale: .164). These differences could be explained by the younger overall age of the Oiltown sample. Respondents from the Oiltown sample were not very different from the other respondents in their experience of stressful events, and their belief in the availability of psychological resources was no different than the respondents from the other communities. Respondents from the Oiltown sample had fewer social contacts (-.133) and expressed fewer feelings of anomia and alienation (-.085), yet expressed more feelings of social disconnection

(.341) compared to respondents of the other communities. These respondents also expressed slightly higher levels of stress (.092) than respondents of the other communities. There was no difference in expression of feelings of arousal, or in feeling tension, depression or anger, and these respondents were not more or less likely to express positive emotions.

Table 13: Correlation of Community with Measures in the Model

Measure Type	Specific Measure	β	p-value
Environmental Demands	Gender	.108	.01
	Age	-.187	.01
	Education	.172	.01
	Chronic disease	-.143	.01
	Someone moved in or out	.127	.01
	Job promotion	.140	.01
	Simple Additive	.164	.01
Appraisal	Social contact	-.113	.01
	Social disconnection	.341	.01
	Anomia/alienation	-.085	.05
Self-Perceived Stress	Stress	.092	.05

Table 14 shows the significant correlations between gender and each of the measures in the model representing these subsequent processes. Gender is negatively correlated with the existence of a previously diagnosed chronic disease (-.124), indicating that women were more likely to have a chronic disease diagnosis prior to the study than men. Males are more likely to report a job promotion than females (.162), but are not more likely to experience any of the other events than females. Gender is not correlated with any of the major life events scales, or with the minor weekly stressors scales. Gender is negatively correlated with the measures of social contact (-.111) and arousal (-.169); this replicates findings in the literature that women are more likely to express emotions and to have more frequent social contacts.

Table 14: Correlation of Gender with other Measures in the Model

Model Process	Specific Measure	β	p-value
Environmental Demands	Chronic disease diagnosis	-.124	.01
	Job promotion	.162	.01
Appraisal	Social contact	-.111	.01
Self-Perceived Stress	Arousal	-.169	.01

Table 15 shows the significant correlations of age with each of the other measures in the model. Age is positively correlated with a diagnosis of a chronic disease (.202) and with increased body mass index (.223), but was not associated with activity level. Both these associations also replicate other findings that older people have more chronic diseases than younger people, and older people are more likely to be overweight than younger people. The younger respondents reported more significant life events in the year prior to the study period, with the exception of the death of someone close. Age is also negatively correlated with the event scales, indicating that the younger respondents reported more events than older respondents. However, although age is correlated with the count of the weekly stress inventory items, it is not associated with the respondent's impression of the stressfulness of the event – in other words, the frequency of reported weekly stressful events decreases with age, but the perceived stressfulness of those weekly hassles was unassociated with age. Expression of social disconnection decreased with age (-.200), while the number of social contacts (.119) and self-perceived stress (.162) increased with age. Expression of tension (-.010), depression (-.100) and anger (-.148) also decreased with age. The literature typically reports a negative correlation between age and arousal, but that association was not evident in this sample.

Table 15: Correlation of Age with Measures in the Model

Model Process	Specific Measure	β	p-value
Environmental Demands	Chronic disease diagnosis	.202	.01
	BMI	.223	.01
	Work difficulties	-.107	.05
	Got married	-.153	.01
	Death of someone close	.109	.05
	Financial gains	-.130	.01
	Financial problems	-.118	.01
	Arrival of baby	-.158	.01
	Changed jobs	-.307	.01
	Moved	-.273	.01
	Job promotion	-.188	.01
	Simple Additive	-.190	.01
	Simple Undesirability	-.394	.01
	Holmes Rahe Weighting	-.209	.01
	Hough Weighting	-.129	.01
	Difference score	-.211	.01
	WSI Count	-.139	.05
Appraisal	Social disconnection	-.200	.01
	Social contact	.119	.01
Self-Perceived Stress	Stress	.162	.01
Negative Emotional Response	Tension	-.101	.05
	Depression	-.100	.05
	Anger	-.148	.01

Table 16 shows the significant correlations between previous diagnosis of a chronic disease and the measures of the subsequent processes in the model. Respondents with a chronic disease diagnosis were more likely to have a higher body mass index (.177), but were not more likely to have a lower physical activity level. Previous diagnosis of a chronic disease was also associated with the experience of a number of specific events, as well as with each of the event scales. Respondents who had a previously diagnosed chronic disease expressed less belief in their own psychological resources (.149) but diagnosis of a chronic disease was not correlated with the measures of social contact, social disconnection or anomia and alienation. Respondents with a chronic disease diagnosis expressed greater stress (.201) and higher levels of arousal

(.103). Tension (.190), depression (.180), and anger (.110) were higher for those respondents with a chronic disease, and these respondents were less likely to express positive emotions (-.161). The association between chronic disease diagnosis and emotional responses such as depression and anger have been identified in the literature, typically in studies using a correlational design with data collection occurring at one time period, which makes it difficult to determine which variable is the cause (Whitehead, 1994). A prospective study design, as recommended by Whitehead (1994), and Thoits (1995) was chosen for the current analysis to account for the impact of chronic disease in the stress process.

Table 16: Correlation of Chronic Disease Diagnosis with Measures in the Model

Measure Type	Specific Measure	β	p-value
Environmental Demands	BMI	.177	.01
	Illness or Injury	.270	.01
	Trouble with spouse	.010	.05
	Financial problems	.110	.01
	Illness of someone close	.091	.05
	Simple Additive	.132	.01
	Simple Undesirability	.194	.01
	Holmes Rahe Weighting	.143	.01
	Hough Weighting	.139	.01
	Difference score	-.160	.01
	WSI count	.149	.05
Appraisal	Psychological resources	.149	.01
Self-Perceived Stress	Arousal	.103	.01
	Stress	.201	.01
Negative Emotional Responses	Tension	.190	.01
	Depression	.180	.01
	Anger	.110	.05
	Valence	-.161	.01

Table 17 shows the correlations between BMI and the measures in the model. Body mass index is not significantly associated with very many of the variables in the model, but was positively correlated with a diagnosis of a chronic disease (.177), with two of the individual events and with two of the events scales. As expected, body mass index was negatively correlated with activity level (-.098).

Table 17: Correlation of Body Mass Index with Measures in the Model

Measure Type	Specific Measure	β	p-value
Environmental Demands	Chronic disease	.177	.01
	Activity level	-.098	.05
	Illness or Injury	.128	.01
	Illness of someone close	.085	.05
	Simple Undesirability	.109	.05
	Difference score	-.101	.05

As discussed above, stressful events were measured using two different methods, one identifying major life events, and the other focusing on more minor everyday hassles using the Weekly Stress Inventory. The responses to these two questionnaires were also combined into scales to identify the relative impact or stressfulness of the events.

Table 18 shows the significant correlations between each major life event and the endogenous measures in the model. As expected, most of the events have some kind of impact on the psychological responses of the individual. In many cases, the lack of significant association is as important and revealing as the existence of a significant association – for example, expression of anger is associated with separation or divorce (.116), trouble with spouse (.226), financial problems (.184), changing jobs (.085) and illness of someone close (.127), but is not associated with work-related difficulties, retirement, illness, death of someone close, improvement in finances, or having someone move in or out of the home. These associations could be considered as describing a constellation of 'typical' responses to specific external events: people who get separated or divorced are more likely to express those specific emotions of depression, anxiety or anger, and express less trust in their own abilities to overcome their problems, and less trust in the community's support. Respondents who were recently retired or quit their jobs were more likely to express doubt about their own psychological resources, and about the support of the community.

The lack of association between the social and psychological measures and many of the measures of positive life events replicates the findings in the literature that these positive events are not associated with either feelings of stress.

Table 18: Correlation of Major Life Events with Measures in the Model

Major Life Event	Other Measures in the Model	β	p-value
Lost job or been unemployed	None		
Work-related difficulties	Psychological Resources	.118	.01
	Social contact	-.084	.05
	Stress	.153	.01
	Tension	.117	.01
	Depression	.120	.01
	Valence	-.174	.01
Got married	None		
Separated or divorced	Psychological resources	.107	.05
	Social disconnection	.103	.05
	Anger	.116	.01
	Tension	.127	.01
	Depression	.123	.01
	Valence	-.097	.05
Quit or retired	Psychological resources	.101	.05
	Social disconnection	.135	.01
Illness or injury	WSI count	.154	.05
	WSI stressfulness	.171	.01
	Psychological resources	.169	.01
	Stress	.124	.01
	Tension	.166	.01
	Depression	.154	.01
	Valence	-.086	.05
Death of someone close	WSI count	.220	.01
	WSI stressfulness	.182	.01

Major Life Event	Other Measures in the Model	β	p-value
Trouble with spouse	WSI count	.161	.05
	WSI stressfulness	.157	.05
	Psychological resources	.140	.01
	Social disconnection	.131	.01
	Stress	.203	.01
	Anger	.226	.01
	Tension	.203	.01
	Depression	.147	.01
	Valence	-.153	.01
Improvement in finances	Psychological resources	-.095	.05
	Stress	-.089	.05
	Depression	-.085	.05
Strike or laid off	Depression	-.086	.05
Financial problems	WSI count	.242	.01
	Psychological resources	.206	.01
	Stress	.345	.01
	Anger	.184	.01
	Tension	.154	.01
	Depression	.174	.01
	Valence	-.232	.01
Arrival of baby	None		
Someone moved in or out	Psychological resources	.101	.05
	Social disconnection	.097	.05
Started working or changed jobs	Social disconnection	.092	.05
	Anger	.085	.05
Illness or injury of someone close	WSI count	.140	.01
	WSI stressfulness	.195	.05
	Psychological resources	.106	.05
	Social disconnection	.129	.01
	Stress	.091	.05
	Arousal	.096	.05
	Anger	.127	.01
	Tension	.170	.01
	Depression	.120	.01
	Valence	-.148	.01
Changed residence	Depression	.117	.01
Promotion at work	WSI count	.154	.05
	Stress	.101	.05

Most studies that measure major life events use a composite scale to evaluate the impact on health outcomes. Table 19 shows the significant correlations between the composite scales and the endogenous measures in the model. The simple additive scale was significantly correlated with the identification of weekly hassles (WSI count), but was not correlated with the individual's assessment of the stress caused by those stressors (WSI stressfulness). With the exception of the desirability scale which is only associated with social disconnection, all the event scales are significantly correlated with the measures of weekly stressors, two measures of social and psychological resources, and the measures of negative emotional response. The Holmes/Rahe weighting scheme produces almost the same associations as the Hough weighting, and the size of the slopes are similar. However, the Hough scale is not significantly associated with arousal.

Table 19: Correlation between Event Scales and Endogenous Measures

Event Scale	Other Measures	β	p-value
Simple additive	WSI count	.287	.01
	Psychological resources	.197	.01
	Social disconnection	.195	.01
	Arousal	.103	.05
	Stress	.184	.01
	Tension	.149	.01
	Depression	.142	.01
	Anger	.137	.01
	Valence	-.174	.01
Simple Desirability	Social disconnection	.107	.05
Simple Undesirability	WSI count	.310	.01
	WSI stressfulness	.159	.05
	Psychological resources	.271	.01
	Social disconnection	.163	.01
	Arousal	.108	.05
	Stress	.232	.01
	Tension	.249	.01
	Depression	.234	.01
	Anger	.235	.01
	Valence	-.274	.01
Holmes Rahe Weighting	WSI count	.302	.01
	Psychological resources	.209	.01
	Social disconnection	.184	.01
	Arousal	.102	.05
	Stress	.172	.01
	Tension	.189	.01
	Depression	.191	.01
	Anger	.182	.01
	Valence	-.180	.01

Event Scale	Other Measures	β	p-value
Hough Weighting	WSI count	.271	.01
	Psychological resources	.243	.01
	Social disconnection	.155	.01
	Arousal	--	--
	Stress	.163	.01
	Tension	.166	.01
	Depression	.182	.01
	Anger	.173	.01
	Valence	-.188	.01
Difference Score	WSI count	-.206	.01
	WSI stressfulness	-.149	.05
	Psychological resources	-.252	.01
	Social disconnection	--	--
	Arousal	--	--
	Stress	-.159	.01
	Tension	-.189	.01
	Depression	-.172	.01
	Anger	-.172	.01
	Valence	.241	.01

Each method of scaling results in minor differences in associations with the outcome measures, and the correlations with some of the diagnoses are significant although they are not significantly correlated with an individual event. Major life events lists are typically combined into a scale for ease of data analysis when using multiple regression techniques, but also for purely theoretical reasons: the assumption is that all events cause a similar physiological response (stress) and therefore the differences between events should be negligible or have a cause unassociated with the pure stress response. There is no evidence from these basic correlations that combining the events into a scale identifies associations that are not evident in the associations with the individual measures of events, and some of the specific associations worth further exploration are lost.

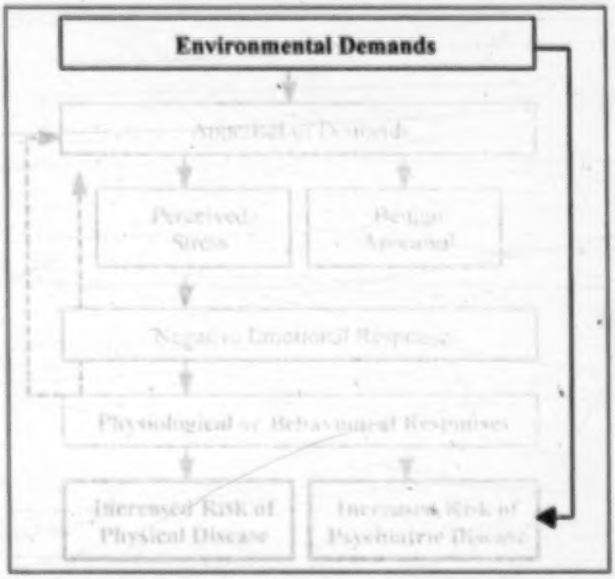
Table 20 shows the correlation coefficients for those measures that were significantly associated with the weekly stress inventory. The number of events identified on the weekly stress inventory were positively correlated with arousal and valence and with the measures of negative emotional response, but the respondent's evaluation of the stressfulness of the events was not correlated with any measure except the measure of anomia and alienation. The correlation between the weekly stress inventory and the measures of negative emotional response supports the findings in the literature that the greater frequency of experiencing daily or weekly hassles causes an increase in symptoms of depression or other negative affect.

Table 20: Correlation between the Weekly Stress Inventory and the Measures of Appraisal, Self-Perceived Stress and Negative Emotional Response

Weekly Stress Inventory Scale	Other Measures	β	p-value
WSI Count	Stress	.244	.01
	Arousal	.154	.01
	Valence	-.148	.01
	Tension	.114	.01
	Depression	.130	.01
	Anger	.126	.01
WSI Stressfulness	Anomia/alienation	.207	.01

The correlations among the variables outlined above replicates or at least provides support for the findings in the literature. The correlations indicated that environmental demands, including the risk factors, major life events and the weekly stress inventory, all increase the level of self-perceived stress, depression, tension and anger. Each of the weighting scales was associated with the appraisal measures and the measures of outcome typically used in the literature: self-reported symptoms of depression, tension and elevated levels of anger. The correlation analysis supports the argument that the scales represent the amount of change, and provides some evidence of an effect on the level of depression. However, there is no way of determining which scale is more predictive of actual diagnosis of a health condition without consideration of the correlations between these measures of environmental demands and the measures of subsequent diagnosis.

The next step in the analysis, therefore, was to determine if the measures of environmental demands were correlated with any of the measures of health outcome, represented by the black arrow in the diagram at the right. Table 21 shows the correlations between the measures of community, gender, age, body mass index, and chronic disease diagnosis and diagnosis of a health condition subsequent to the study period.


Environmental Demands
Appraisal of Demands
Perceived Stress
Benign Arousal
Negative Emotional Response
Physiological or Behavioural Responses
Increased Risk of Physical Disease
Increased Risk of Psychiatric Disease

A large number of diagnoses are more common in the Oiltown community sample compared to the samples from the other communities. Respondents from the Oiltown sample were more likely to be diagnosed with almost all the diseases included in the analysis. Although independent analysis indicated that the sample respondents were not diagnosed more frequently with any of these conditions in comparison with other people in the community[11], or in comparison with other people in the province, this comparison of the community samples indicates that there are significant differences in diagnosis that will have to be considered in the analysis of the model of the stress process.

---

[11] Health Surveillance, 2000. *Alberta Oilsands Community Exposure and Health Effects Assessment Program: Technical Report,* Alberta Health and Wellness.

Gender is negatively correlated with ischemic heart disease (-.086), pneumonia and influenza (-.118), complications of pregnancy (-.098), and diagnosis of a blood disorder (-.086) and is positively correlated with cardiac dysrhythmias (.130) and other conditions (.155). In other words, men are more likely to suffer cardiac dysrhythmias and be diagnosed with an 'other condition', while women are more likely to be diagnosed with ischemic heart disease, pneumonia or influenza, a blood disorder, and conditions associated with pregnancy. As expected, age was positively associated with diabetes (.095) and heart problems (ischemic heart disease .139; and cardiac dysrhythmias .103). Age was negatively correlated with a diagnosis of a respiratory disorder (-.116) and ill-defined conditions (-.104) , indicating that younger respondents were more likely to visit a physician for respiratory illnesses that older respondents.

Respondents who were previously diagnosed with a chronic disease were more likely to be diagnosed with chronic obstructive pulmonary disease (COPD) (.106) or bronchitis (.092).

Body mass index was positively correlated with a subsequent diagnosis of breast cancer (.096), diabetes (.153), heart disease (.088) and hypertension (.158). In other words, respondents who were overweight were more likely to be diagnosed with one of these diagnoses in the year following the study.

Table 21: Correlation between Community, Gender, Age, Chronic Disease and BMI and Diagnosis

Environmental Demand	Diagnosis	β	p-value
Community	Endocrine/immune system	.167	.01
	Blood system	.122	.01
	Mental health disorder	.289	.01
	Nervous system	.191	.01
	Circulatory system	.226	.01
	Ischemic heart disease	.107	.01
	Cardiac dysrhythmia	.177	.01
	Bronchitis	.103	.01
	Digestive system disorder	.199	.01
	Genitourinary system	.144	.01
	Musculoskeletal system	.166	.01
	Other condition	.226	.01
	Hypertension	.120	.01
	Respiratory infection	.089	.05
	Injury	.161	.01
Gender	Ischemic heart disease	-.086	.01
	Cardiac dysrhythmias	.130	.01
	Pneumonia/influenza	-.118	.01
	Blood disorder	-.086	.05
	Pregnancy conditions	-.098	.05
	Other conditions	.155	.01
Age	Diabetes	.095	.05
	Ischemic heart disease	.139	.01
	Cardiac dysrhythmias	.103	.01
	Respiratory system	-.116	.01
	Respiratory infection	-.096	.05
	Pregnancy conditions	-.090	.05
	Other conditions	-.104	.05
Chronic Disease Diagnosis	COPD	.106	.05
	Bronchitis	.092	.05
BMI	Breast cancer	.096	.05
	Diabetes	.153	.01
	Ischemic heart disease	.088	.05
	Hypertension	.158	.01

Table 22 shows the health outcomes that are significantly correlated with each major life event. Most of the events were correlated with at least one diagnosis, and some were correlated with a number of different diagnoses. Respiratory system diseases were correlated with a number of different events including divorce, strike, starting or changing jobs, and changing residence, and specific diagnoses of the respiratory system were associated with a few additional events, including retirement, illness or injury, financial problems, and changing residence. Some diagnoses are only associated with specific events, such as the correlation between nervous system disorder and financial problems or having someone move in or out of the house.

Table 22: Correlation of Major Life Events with Diagnoses

Major Life Event	Diagnosis	β	p-value
Lost job or been unemployed	Mental health	-.097	.05
	Injury	.091	.05
Work-related difficulties	None	--	--
Got married	Stomach	.087	.05
Separated or divorced	Respiratory system	.160	.01
	Respiratory infection	.154	.01
	Digestive system	.087	.05
Quit or retired	COPD	.138	.01
Illness or injury	Chronic disease	.270	.01
	COPD	.096	.05
Death of someone close	Cardiac dysrhythmia	.108	.05
Trouble with spouse	Chronic disease	.101	.05
	Stomach	.085	.05
Improvement in finances	Circulatory system	.102	.05
	Breast cancer	.105	.05
Strike or laid off	Respiratory system	.104	.05
	Respiratory infection	.147	.01
	Digestive system	.091	.05
	Pregnancy conditions	.086	.05
Financial problems	Chronic disease	.110	.01
	Nervous system	-.116	.01
	Pneumonia	.103	.05
	COPD	.119	.01
Arrival of baby	Skin disorder	.086	.05
Someone moved in or out	Nervous system	-.085	.05
	Digestive system	.084	.05
	Skin condition	.095	.05
	Other condition	.131	.01
Started working or changed jobs	Breast cancer	.109	.01
	Arteries	.103	.05
	Respiratory system	.113	.01
	Respiratory infection	.086	.05
	Musculoskeletal system	.085	.05
	Other condition	.097	.05
Illness or injury of someone close	Chronic disease	.091	.05
	Diabetes	.098	.05
	Arteries	.147	.01

Major Life Event	Diagnosis	β	p-value
Changed residence	Circulatory system	-.092	.05
	Cardiac dysrhythmias	-.100	.05
	Respiratory system	.149	.01
	Bronchitis	.087	.05
	Respiratory infections	.121	.01
	Ill defined conditions	.103	.05
Promotion at work	Arteries	.114	.01
	Ill defined conditions	.102	.05
	Other conditions	.178	.01

Table 23 shows the significant correlations between the major life event composite scales and the diagnoses. Most of the scales are significantly correlated with poor respiratory health outcomes. Of significance is the association between two of the scales – the Simple Undesirability and the Hough weighting scale - and the diagnosis of a nervous system disease. The scale representing the positive life events is negatively correlated with pneumonia and diabetes (fewer respondents who experienced the positive events were diagnosed with these conditions), but positively correlated with respiratory system disorders and respiratory infections, with diseases of the arteries, with other conditions and with ill-defined conditions (respondents who experienced the positive events were more likely to be diagnosed with these conditions).

Table 23: Correlation between Composite Event Scales and Diagnosis

Composite Event Scale	Diagnosis	β	p-value
Simple additive	Respiratory system	.120	.01
	Respiratory infection	.104	.01
	Other condition	.104	.01
Simple Desirability	Respiratory system	.141	.01
	Respiratory infection	.106	.05
	Pneumonia/influenza	-.084	.05
	Diabetes	-.084	.05
	Arteries	.122	.01
	Other condition	.156	.01
	Ill defined condition	.126	.01
Simple Undesirability	Respiratory system	.090	.05
	Pneumonia/influenza	.089	.05
	Nervous system	-.113	.01
Holmes Rahe Weighting	Respiratory system	.138	.01
	Respiratory infection	.124	.01
Hough Weighting	Respiratory system	.117	.01
	Respiratory infection	.114	.01
	Nervous system	-.108	.05
Difference Score	Breast cancer	.091	.05
	Pneumonia/influenza	-.130	.05
	Diabetes	-.088	.01
	Other conditions	.111	.01

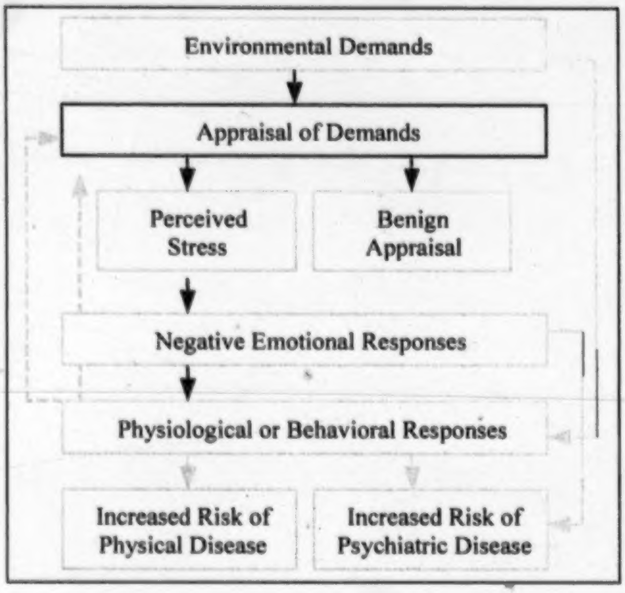
The large number of correlations between the measures of environmental demands and diagnosis provide support for the first hypothesis that the response to environmental demands could be characterised as non-specific because the environmental demands affect a wide variety of diagnoses. Although each of the events is correlated with a different array of diagnoses, most of the measures are correlated with at least one.

The list of major life events are typically grouped into scales because of the theoretical approach which argues that although all people are not equally exposed to major life events, exposure to any event that results in a similar magnitude of change should have the same effect on health outcome. However, the correlations between the composite scales and the diagnoses do not support the argument that the scale scores represent an overall level of change which causes the development of health conditions. Due to the reduction in the number of diagnoses correlated with the events after they are combined into scales, the scales were not included in any subsequent analysis.

Although the weekly stress inventory was significantly correlated with arousal and valence and with some of the composite scales of major life events, neither method of scoring the tool is correlated with any diagnoses. The events that are measured by the WSI are likely not significantly correlated to a health outcome because the events themselves are not significant enough on their own to cause a change in health. Furthermore, many items on the scale are insignificant enough that they would only be noted by someone who was already feeling aroused and therefore views minor daily hassles as significant. The significant correlations with the measures of arousal and self-perceived stress indicates that the WSI scale, like many of the other scales designed to measure stressful events, confounds the measurement of events with the measurement of the emotional response to those events, and thereby looses the ability to differentiate between the measures of the dependent and the independent variables. Due to the lack of correlations between the weekly stress inventory and any of the diagnoses, the weekly stress inventory was not included in any subsequent analysis.

Appraisal of Demands: Psychological and Social Resources

The next step in the process according to the model is the effect of the appraisal process on self-perceived stress, and negative emotional response, represented by the black arrows in the diagram on the next page. Table 24 shows the significant correlations between the psychological and social resources used in the appraisal process and the endogenous measures in the model.


Environmental Demands
Appraisal of Demands
Perceived Stress
Benign Appraisal
Negative Emotional Responses
Physiological or Behavioral Responses
Increased Risk of Physical Disease
Increased Risk of Psychiatric Disease

Lack of belief in the availability of psychological resources is associated with all the other measures of social resources, and with the measures of self-perceived stress and negative emotional response. As we would expect from the evidence in the literature, lack of belief in psychological resources is negatively associated with frequency of social contact – respondents who had more frequent contact with other people were less likely to believe they lacked personal psychological resources. Social contact is negatively correlated with the measures of self-perceived stress and all the measures of negative emotional response. This relationship reflects the most commonly reported finding in the social psychological literature: low self esteem is correlated with low social contact, and frequency of social contact is directly associated with happiness or the expression of positive emotions.

Table 24: Correlation between the Measures of Appraisal and Other Measures

Appraisal Measure	Other measures	β	p-value
Psychological resources	WSI count	.133	.05
	Social contact	.138	.01
	Social disconnection	.116	.01
	Arousal	--	--
	Stress	.317	.01
	Tension	.428	.01
	Depression	.508	.01
	Anger	.376	.01
	Valence	-.541	.01
Social contact	Psychological resources	-.138	.01
	Social disconnection	--	--
	Arousal	--	--
	Stress	-.132	.01
	Tension	-.121	.01
	Depression	-.101	.05
	Anger	-.110	.05
	Valence	.120	.01
Social disconnection	Psychological resources	.116	.01
	Arousal	-.094	.05
	Stress	.089	.05
	Tension	.119	.01
	Depression	.131	.01
	Anger	.145	.01
	Valence	--	--
Anomia/alienation	WSI stressfulness	.207	.01

Social disconnection is positively correlated with the measure of self-perceived stress, with lack of belief in the availability of psychological resources, and with the measures of negative emotional response, but negatively correlated with the measure of arousal. Social disconnection was not correlated with the number of contacts with friends and family, nor was it correlated with the measure of anomia and alienation, indicating that this measure is independent and measuring a unique attitudinal dimension.

A sense of anomia or alienation is not correlated with any other measures in the model with the exception of the weekly stress inventory. As a result of this preliminary analysis, this measure was excluded from subsequent analysis.

The above analysis of the correlations between the measures of psychological and social resources provides support for findings in the literature (e.g. Pearlin and Schooler, 1978) that lack of belief in personal and social resources increases the level of self-perceived stress, expression of negative emotions, and symptoms of non-clinical levels of depression. However, there is no way of determining whether the belief in the availability in psychological and social resources is predictive of actual diagnosis of a health condition without consideration of the correlations between these measures of environmental demands and the measures of subsequent diagnosis.

The next step in the analysis, therefore, was to determine if the measures of the social and psychological factors used in the appraisal process were correlated with any of the measures of health outcome, represented by the black arrow in the diagram at the right.

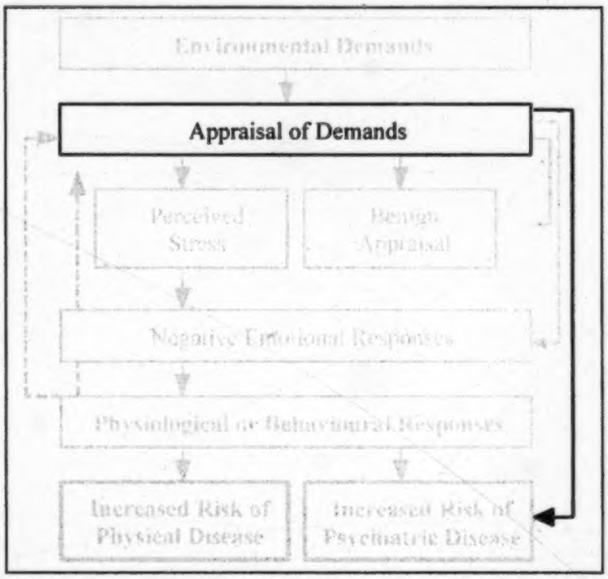

Environmental Demands
Appraisal of Demands
Perceived Stress
Benign Appraisal
Negative Emotional Responses
Physiological or Behavioural Responses
Increased Risk of Physical Disease
Increased Risk of Psychiatric Disease

Table 25 shows the correlations between the measures of lack of belief in psychological resources, social contact, social disconnection and anomia/alienation with diagnosis of a health condition subsequent to the study period.

Lack of belief in the availability of psychological resources is only correlated with two diagnoses: a diagnosis of bronchitis (.115) and with COPD (.187). Respondents who expressed a lack of belief in their psychological resources were more likely to be diagnosed with either of these two conditions after the study period. Social disconnection is correlated with a subsequent diagnosis of a respiratory system disease (.121), a respiratory infection (.111), a mental health disorder (.130), a disease of the nervous system (.164), a circulatory system disease (.152) or an other unidentified condition (.141). Social disconnection appears to be sufficiently associated with a number of the outcome variables to be included in subsequent analyses. Social contact and anomia/alienation were not associated with any health diagnoses, and were therefore excluded from subsequent analysis.

Again, the correlations between the components of the first half of stress process provide ample support for the overall model, but the analysis of the correlations between the measures and an actual diagnosis bring the validity of the model into question.

Table 25: Correlations between the Psychological and Social Factors in Appraisal and Diagnosis

Appraisal Measure	Diagnosis	β	p-value
Psychological resources	Bronchitis	.115	.01
	COPD	.187	.01
Social contact	None	--	--
Social disconnection	Respiratory system	.121	.01
	Respiratory infection	.111	.05
	Mental health	.130	.01
	Nervous system	.164	.01
	Circulatory system	.152	.01
	Digestive system	.109	.05
	Other condition	.141	.01
Anomia/alienation	None	--	--

SELF-PERCEIVED STRESS

The next step in the process according to the model is the effect of self-perceived stress on negative emotional response, represented by the black arrow in the figure on the right. Table 26 shows the correlations between the measures of arousal and self-perceived stress and the measures of negative emotional response. Arousal is positively associated with the measure of self-perceived stress and with the measures of negative emotional response. Self-perceived stress is positively correlated with arousal, and with the measures of negative emotional response (tension, depression and anger). These correlations reflect the findings in the literature that people who say they feel stressed also express symptoms associated with sub-clinical depression, with anger, and with higher levels of tension. Both measures are sufficiently correlated with the measures of negative emotional response, and both measures provide support for the findings in the literature that self-perceived stress has a negative effect on mental health – increased levels of stress are associated with increased symptoms of non-clinical depression, and increased expression of negative emotions like anger and tension. However, although the correlation between the constructs supports the stress process model, arousal and valence are typically independent in the literature.

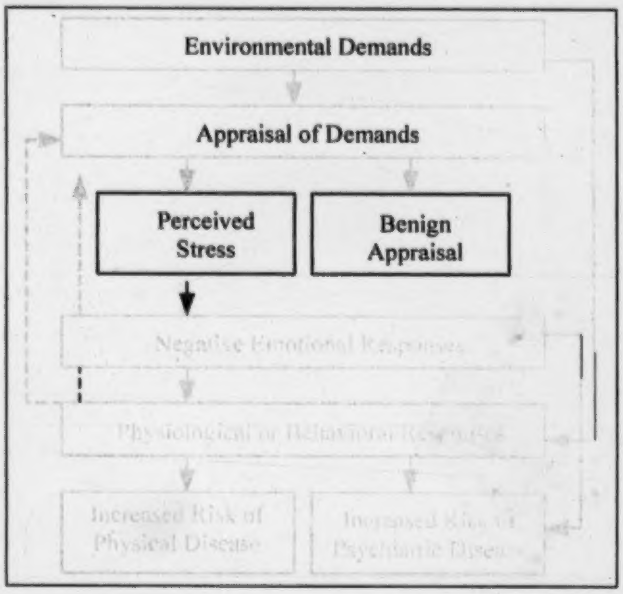

Environmental Demands
Appraisal of Demands
Perceived Stress
Benign Appraisal
Negative Emotional Responses
Physiological or Behavioral Responses
Increased Risk of Physical Disease
Increased Risk of Psychiatric Disease

Table 26: Correlation between Arousal and Self-Perceived Stress and Negative Emotional Response

Response Scale	Other measures	β	p-value
Arousal	Stress	.112	.01
	Tension	.151	.01
	Depression	.123	.01
	Anger	.145	.01
	Valence	-.409	.01
Stress	Arousal	.112	.01
	Tension	.349	.01
	Depression	.315	.01
	Anger	.310	.01
	Valence	-.384	.01

The next step in the analysis was to evaluate the effect of the two measures of self-perceived stress on diagnosis, represented by the black arrow in the figure on the right.

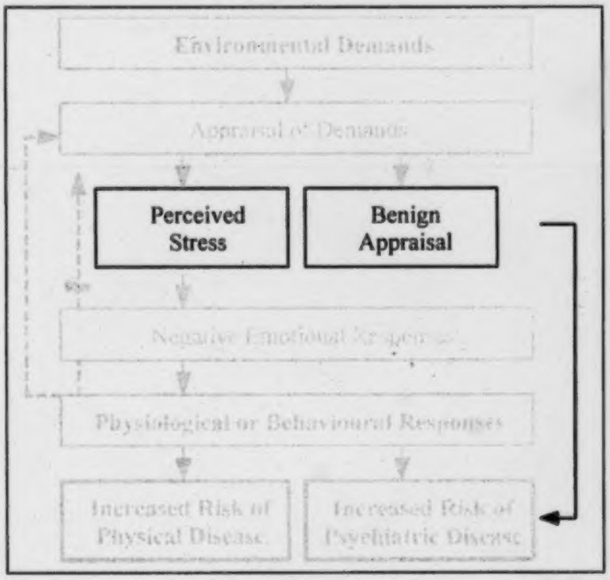

Environmental Demands
Appraisal of Demands
Perceived Stress
Benign Appraisal
Negative Emotional Responses
Physiological or Behavioural Responses
Increased Risk of Physical Disease
Increased Risk of Psychiatric Disease

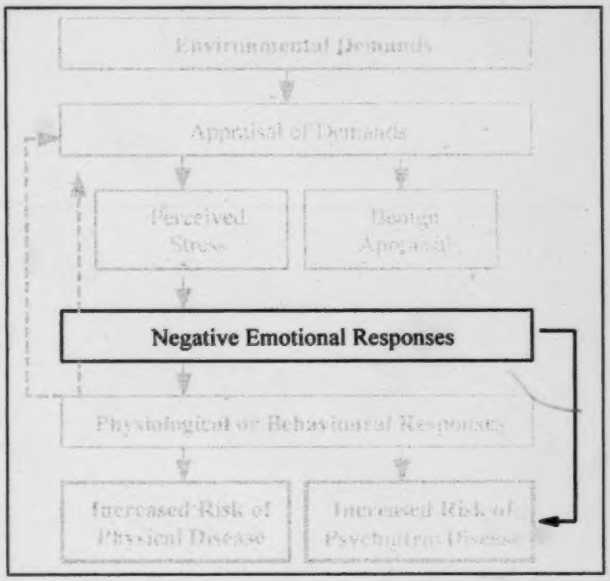
Table 27 shows the correlations between the measures of arousal and self-perceived stress and the measures of diagnosis. Arousal is negatively correlated with a diagnosis of hypertension (-.099) and with ‘other conditions’ (-.126), a diagnosis typically used to describe physical complaints that are not otherwise classifiable or diagnosable. Self-perceived stress is positively correlated with a diagnosis of a circulatory disease (.103) and a digestive system disease (.104). This analysis indicates that neither measure of stress is sufficiently correlated with the diagnosis of a health condition to be used to predict either Selye's conceptualization of a stress response, or the effects of environmental demands on health outcomes.

Table 27: Correlation between Arousal and Self-Perceived Stress and Diagnosis

Response Scale	Other measures	β	p-value
Arousal	Hypertension	-.099	.05
	Other condition	-.126	.01
Self-Perceived Stress	Circulatory system	.103	.05
	Digestive system	.104	.05

NEGATIVE EMOTIONAL RESPONSE

The final step in the process according to the model is the effect of negative emotional response on diagnosis, represented by the arrows in the figure at the right. Table 28 shows the correlations between the measures of negative emotional response and diagnosis.


Environmental Demands
Appraisal of Demands
Perceived Stress
Benign Appraisal
Negative Emotional Responses
Physiological or Behavioural Responses
Increased Risk of Physical Disease
Increased Risk of Psychiatric Disease

The tension mood scale provides a measure of the general anxiety level of the individual. The tension scale was positively correlated with a diagnosis of pneumonia (.135) but was not correlated with any other diagnosis. The measure of depression reflects depressed mood, rather than clinical depression, and is similar to the measures commonly used in the literature to define a negative mental health condition. Depression is positively correlated with a diagnosis of bronchitis (.150) and a diagnosis of COPD (.089), but was not correlated with any other health condition. Anger was positively correlated with more diagnoses than the other measures of negative affect: anger was positively correlated with a diagnosis of pneumonia (.092), bronchitis (.109), COPD (.090) and with pregnancy conditions (.096). The association between anger and coronary heart disease (CHD) found by Cheng and others was not evident from the correlation analysis. Valence was only correlated with two diagnoses: diabetes (.098) and an other condition (.115).

Table 28: Correlation between Negative Emotional Response and Diagnosis

Response Scale	Other measures	β	p-value
Tension	Pneumonia	.135	.01
Depression	Bronchitis	.150	.01
	COPD	.089	.05
Anger	Pneumonia/influenza	.092	.05
	Bronchitis	.109	.01
	COPD	.090	.05
	Pregnancy conditions	.096	.05
Valence	Diabetes	.098	.01
	Other condition	.115	.05

SUMMARY

The correlation analysis provided some support for the findings in the literature, particularly the associations between the measures of the stress process and depressed mood. However, the analysis of the correlations between the measures of the stress process and health diagnosis did not provide as much support for Cohen, Kessler and Gordon's model. The individual events were significantly correlated with a number of diagnoses, suggesting some support for the first hypothesis that the response to stressful events is non-specific and events have an effect on a number of diagnoses. Most of the indicators of social or psychological response to stress were associated with at least one diagnosis, and some diagnoses were associated with a number of the indicators in the model. The proposed measure of social disconnection was correlated with more diagnoses than any other measure of the social and psychological process in the stress process model, indicating that this is an important measure to investigate further. Detailed discussion of this measure is deferred to the final chapters.

In general, the evidence supporting the stress process model is not overwhelming, because correlation analysis is not a useful tool for evaluating a complex model. The next step in the analysis was to apply Structural Equation Modelling (SEM) techniques, which allow for factor analysis and multiple regression analysis to be conducted simultaneously.

CHAPTER 5: TESTING THE COMPLETE MODEL

The analysis of the complete model was conducted with M-Plus statistical software, using individual level data and the ML method of estimation. A series of MIMIC models were examined to test the measurement model and further refine the estimates of the effects. Initially, each of the latent variables was considered in turn, to define the endogenous latent variables in the model. Each latent variable and the associated measures were added to determine if any of the residual variance in the measures could be used to explain variance in other latent variables. Once the latent variables were sufficiently modelled, the causal association between the exogenous causal variables and the latent endogenous measures in the model were considered. Finally, each diagnosis was added independently to the model to determine whether the psycho-social model explained any of the variation in receiving that diagnosis. The model was initially described, and then non-significant relationships were removed from the model, to ensure that only the relevant measures were included in the final re-specified model.

The 'goodness of fit' of an SEM model can only be tested in the case of an over-identified model, or one in which there are more variances and covariances than needed to estimate the parameters in the model. A model fits when the values of the statistics implied by the parameters are close to the observed values. The χ^2 statistic is used to assess this fit, and a non-significant chi-square statistic indicates that the model and the null hypothesis are not sufficiently different to be statistically significant. χ^2 is sensitive to sample size and significant values are typical, so a more commonly used measure of goodness of fit is a χ^2 that is less than twice the number of the degrees of freedom.

According to Thompson (2000), structural equation models are considered acceptable when several statistical tests reached an acceptable goodness of fit: the χ^2 statistic must be non-significant; the fit indices should greater than .95, and the root mean square error of approximation should be .08 or less. Further, all associations that have a t-value of less than | 2.0 | should be removed from the model.

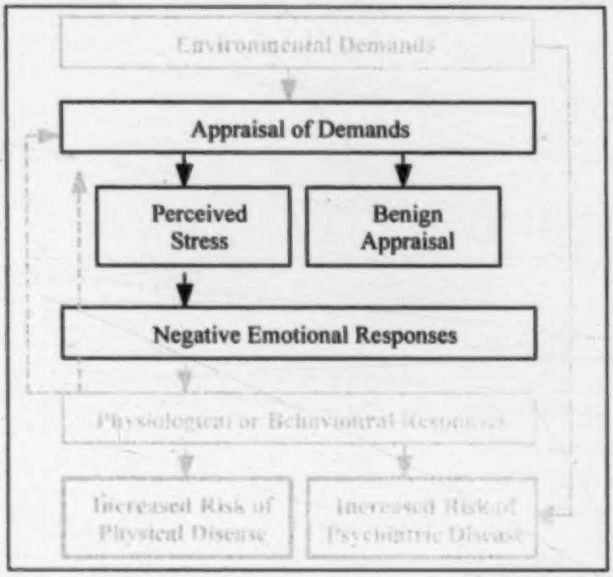
According to overall fit criteria, the model resulted in a very good fit of the data for most diagnoses. Although the χ^2 value changed slightly depending upon the diagnosis in the model, the overall fit remained statistically significant and all χ^2 values were not signficiant. Table 29 shows the fit criteria for each diagnosis tested with the model.

Table 29: Measures of Significance of the Model

Diagnosis	χ^2	df	p-value	TLI	CFI	RMSEA
Neoplasms	875.856	822	.0940	.983	.985	.012
Breast cancer	993.140	934	.0876	.982	.984	.012
Endocrine/immune	894.721	821	.0372	.977	.988	.014
Diabetes	889.712	818	.0409	.978	.981	.014
Blood diseases	1003.831	935	.0583	.979	.981	.013
Mental disorders	875.776	818	.0789	.982	.984	.013
Nervous system	842.439	791	.0998	.984	.986	.012
Circulatory system	880.828	819	.0659	.981	.983	.013
Ischemic heart disease	875.531	817	.0762	.982	.984	.013
Cardiac dysrhythmias	855.442	791	.0554	.980	.983	.014
Cerebrovascular disease	875.222	816	.0738	.982	.984	.013
Arteries	829.775	792	.1708	.989	.990	.010
Respiratory system	934.771	875	.0788	.983	.985	.012
Pneumonia	882.471	818	.0582	.980	.983	.013
Chronic bronchitis	853.403	793	.0673	.982	.984	.013
Other chronic obstruction	900.085	817	.0224	.975	.978	.015
Digestive system	846.694	791	.0830	.983	.985	.013
Genitourinary system	No association					
Complications of Pregnancy	888.794	818	.0428	.978	.981	.014
Musculoskeletal system	879.483	819	.0700	.981	.984	.013
Ill-defined conditions	No association					
Injury	887.167	818	.0464	.979	.987	.014
Hypertension	876.266	820	.0845	.983	.985	.013
Pulmonary Disease	874.169	797	.0220	.975	.978	.015

DEFINING THE LATENT MEASURES OF THE APPRAISAL PROCESS

The first step in the development of the structural equation model analysis was to add all the latent measures of the appraisal process into a single equation to define a causal model for the association between these measures (shown in the diagram at the right). The measures were initially defined according to the theoretical approach, and alterations were made based on the structural equation modelling process.


Environmental Demands
Appraisal of Demands
Perceived Stress
Benign Appraisal
Negative Emotional Responses
Physiological or Behavioural Responses
Increased Risk of Physical Disease
Increased Risk of Psychiatric Disease

The final model of social and psychological measures and the latent variables they measure is shown in Figure 3. The curved lines in the model represent the covariance among the measures shown in square boxes. The variables in ovals represent the latent variables or factors measured by the exogenous variables. This model shows that several of the measures can be defined as contributing to the variance of two or more different latent variables. The emotion items can be used to measure both arousal and valence, and some, such as angry and disgusted, are also correlated with each other - that is, if an individual reports frequently feeling angry, they are also more likely to report feeling disgusted. Considered in isolation, each of the latent variables was well defined by the measures.

Figure 3: Measures of Latent Variables

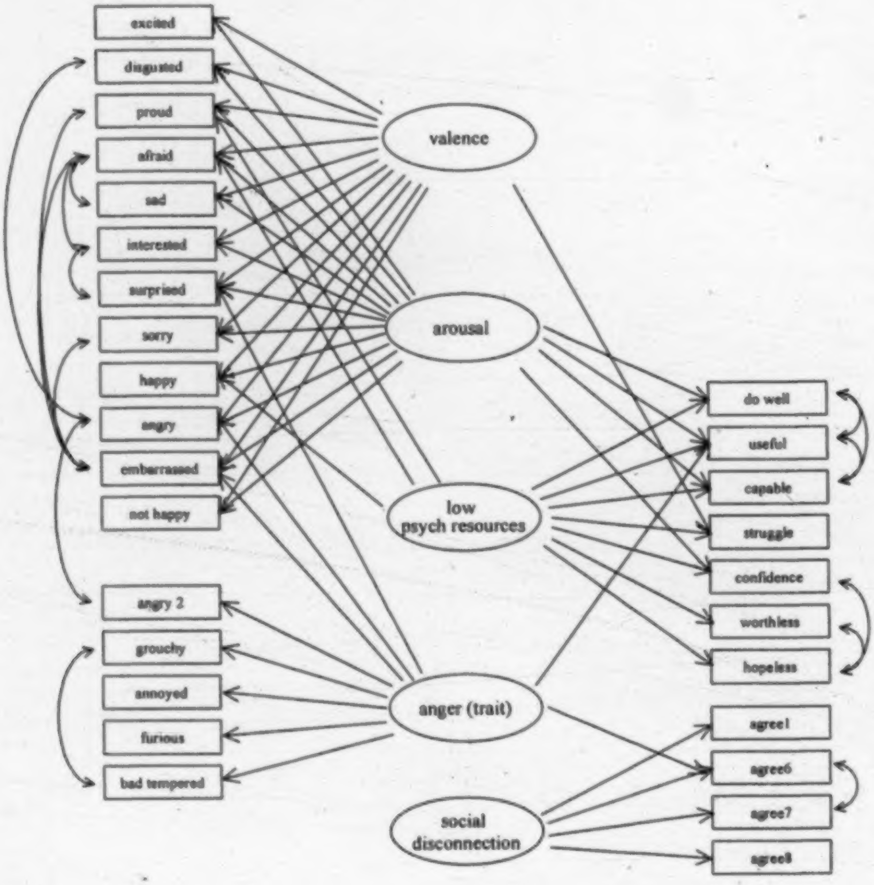

excited
disgusted
proud
afraid
sad
interested
surprised
sorry
happy
angry
embarrassed
not happy
angry 2
grouchy
annoyed
furious
bad tempered
valence
arousal
low
psych resources
anger (trait)
social
disconnection
do well
useful
capable
struggle
confidence
worthless
hopeless
agree1
agree6
agree7
agree8

Table 30 shows the loading of each of the measurement items on the endogenous latent variables, as well as the reliabilities of each of these measures. Loadings that are equal to 1.0 have been fixed and were used to define the latent variables (shaded boxes). The measures which most clearly defined valence and arousal in the factor analysis contribute the largest loading on those latent variables in the structural equation model.

Table 30: Item Reliabilities and Loading of Exogenous Measures on Latent Variables

Measure	Anger	Low Psychological resources	Social disconnect	Arousal	Valence
Angry	0.317			0.629	-1.0
Afraid		0.421		1.0	-1.0
Disgusted				1.0	-1.0
Embarrassed	-0.184			1.0	-0.682
Excited				1.914	1.0
Happy		0.840		1.0	3.529
Interested				1.0	1.789
Proud		-0.719		1.483	1.0
Sad				1.0	-2.331
Sorry				1.0	-1.0
Surprised	-0.197			1.885	1.0
Not happy				-0.547	-2.331
Do well		1.0		-0.306	
Useful	0.135	1.0		-0.595	
Capable		0.784		-0.254	
Struggle		1.0			-1.856
Confidence		2.506		0.515	
Worthless		1.925			
Hopeless		1.607			
Angry (mood)	1.0				
Grouchy (mood)	0.711				
Annoyed (mood)	1.0				
Furious (mood)	0.607				
Bad tempered (mood)	0.656				
Political control			1.0		
Social class	0.462		1.280		
Family breakdown			1.190		
Industry pollution			1.147		

Note: Measures have been coded to reflect a consistent direction. For example, the Worthless and the Useful measures are coded to reflect a similar psychological perspective, with low values representing a positive psychological attitude, and high values representing a negative psychological attitude.

The direct effect of the latent variables on one another are shown in Table 31. The relationships between the latent variables represent a significant proportion of the specified model. It is interesting to note that anger has a direct effect on arousal and valence, but none of the other measures are affected by anger. Lack of belief in the availability of psychological resources decreases arousal, and also decreases valence, but belief in social disconnection only has an effect on arousal. Valence has a negative effect on five latent variables: anger, belief in psychological resources, social resources, arousal, and self-perceived stress level. There is a reciprocal causal effect of valence on anger and of anger on valence, but the larger size of the effect of valence on anger indicates that valence exerts the majority of the effect.

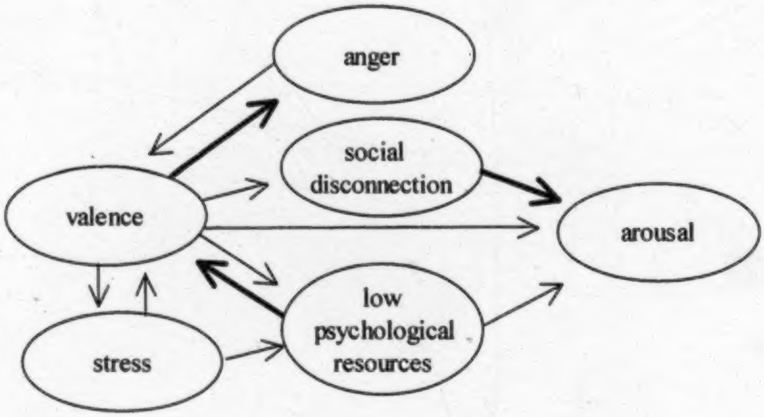
Table 31: Standardised Direct Effects of Latent Variables on One Another

Dependent Variables	Causal Variables					
	Low psych resources	Social disconnect	Arousal	Stress	Anger	Valence
Low psych resources				-0.354		-0.463
Social disconnect						-0.128
Arousal	-0.281	-0.295				-0.451
Stress						-0.733
Anger						-0.433
Valence	-0.672			-.191	-0.161	
Latent Variable R^2	0.499	0.127	.0249	*	.0350	.0721

*note: Stress was not modelled as a latent variable because there was only one measure of stress.

The reduced model of the association between the social and psychological measures in the model is shown in Figure 4. It is clear from the visual presentation of the model that self-perceived stress is not affected by the measures of appraisal as the stress process model would suggest, nor does self-perceived stress have an effect on negative behavioural response. The causal model shows that the level of arousal is affected by more of the measures in the stress process model than the measure of self-perceived stress, and also indicates that arousal is the final measure in the causal chain from environmental demand, through appraisal and evaluation to arousal as a response.

Figure 4: Causal Model of Social and Psychological Variables


anger
social disconnection
valence
arousal
low psychological resources
stress

The next step in the analysis was to add the measures of environmental demands and other exogenous measures to the model of the latent variables, to determine the causal impact of these measures on the stress processes outlined by Cohen's Kessler and Gordon's model shown at right.

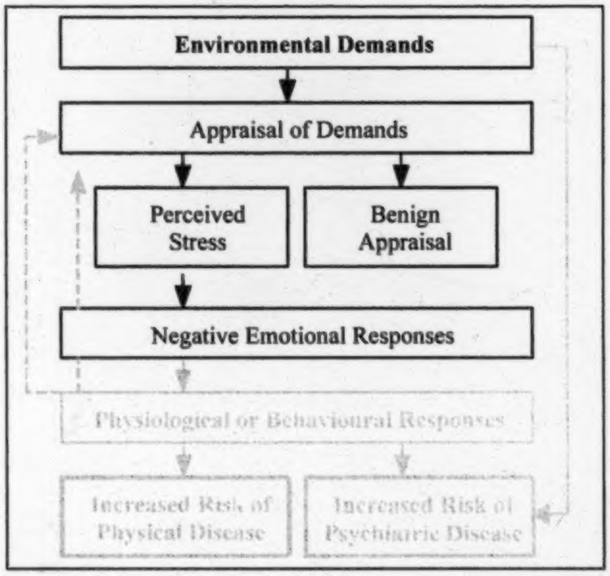

Environmental Demands
Appraisal of Demands
Perceived Stress
Benign Appraisal
Negative Emotional Responses
Physiological or Behavioural Responses
Increased Risk of Physical Disease
Increased Risk of Psychiatric Disease

Table 32 shows the standardised and unstandardised effects of the environmental demands and other exogenous measures on the endogenous measures of psychological and social responses where the relationship was significant. Age had a negative effect on social disconnection (-.228) and a positive effect on valence (.122) – in other words, older people were less likely to express concerns with the social community, and were more likely to express a positive balance of emotions. Women were more likely to be aroused or to say they experienced a variety of emotions with greater frequency than men (-.237). Body mass index did not affect any of the endogenous measures – that is, people who were overweight were not more likely to suffer from lack of belief in psychological resources, to feel isolated from the community, or to be more aroused, angry, or express more or less positive emotions than people who were not overweight. Activity level had a negative effect on belief in psychological resources (-.084); in other words, people who were more active were more likely to believe they had personal psychological resources or strengths. Finally, people who had a previous diagnosis of a chronic disease expressed lower belief in psychological resources (.084), and expressed fewer positive emotions (-.083) than people who did not have a chronic disease.

Many of the events were unassociated with any of the endogenous variables in the model, but where associations were identified, this indicates that the effect of the event on health diagnosis is moderated by the social or psychological measure. For example, belief in psychological resources is affected by job loss (.133), retirement (.048), illness (.110), and financial problems (.123), and these events therefore have an indirect effect on any diagnosis that is affected by a lack of belief in psychological resources. Social disconnection is affected by trouble with their spouse (.112), having someone move into or out of the house (.097), and illness of someone close (.127). Both these endogenous measures are coded negatively so that a higher score means that they have less confidence. Therefore these associations can be interpreted to mean that experiencing these events increases the individual's sense of isolation and inability to cope.

Table 32: Effects of Environmental Demands on Endogenous Variables

Exogenous Measure	Low psychological resources		Social disconnection		Arousal		Valence		Anger	
	b	β	b	β	b	β	b	β	b	β
Age			-.014	-.228			.002	.122		
Gender					-.099	-.237				
BMI										
Activity level	-.004	-.084								
Chronic Disease	.010	.084					-.007	-.083		
Lost job	.101	.133					.077	.130	.345	.173
Work problems							-.045	-.094		
Marriage										
Divorce							-.086	-.104		
Retirement	.052	.048								
Illness	.091	.110								
Death									-.153	-.112
Trouble with spouse			.268	.112			-.063	-.104	.212	.104
Financial improvement					.059	.125				
Strike									-.271	-.071
Financial problems	.067	.123			.059	.116				
Baby										
Someone moved in			.153	.097						
Changed jobs										
Someone ill			.280	.127	.059	.101			.162	.097
Moved										
Job promotion					.059	.087				
Latent Variable R^2	0.499		0.127		0.249		0.721		.0350	

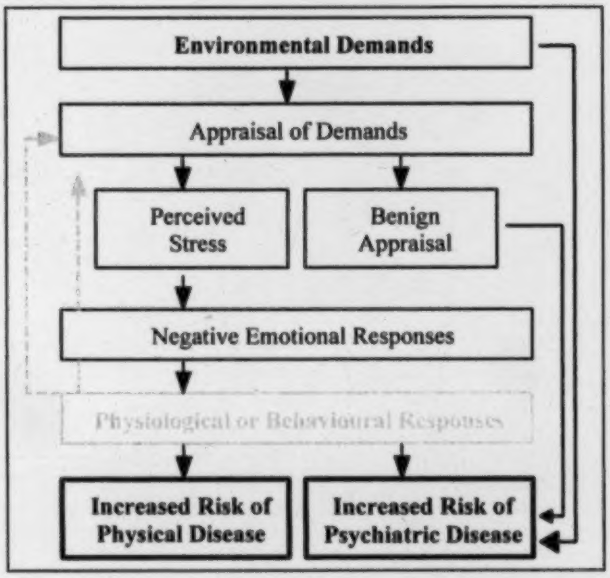
Arousal is affected by both positive (.125) and negative (.116) changes in financial situation, by illness of someone close (.101), and by a job promotion (.087). The standardised slopes were all constrained to be the same for this measure to reduce the number of measures required by the analysis because the unstandardised slopes were all relatively similar.

As one would expect, valence is negatively affected by problems at work (-.094), trouble with their spouse (-.104) and divorce (-.104) but is positively affected by job loss

(.130). Anger is increased by job loss (.173), trouble with their spouse .104), and illness of someone close (.097) but is decreased for people who have experienced a death (-.112) and being on strike (-.071). Although it seems contrary to expectation that being on strike would decrease anger, the measure reflects an event that occurred in the year prior to the study data collection period, and as such represents a strike situation that has been resolved. This could therefore be interpreted to mean that being on strike and resolving work-related issues has a subsequent effect of reducing anger.

MODELLING THE STRESS PROCESS

After determining the appropriate SEM model for the latent variables, the entire model was entered into an SEM equation according to the steps outlined in Cohen's model and discussed above. The complete model was tested separately with each of the health outcomes to determine whether the latent variables had a similar effect on all diagnoses. Although all the exogenous variables were initially entered into the SEM model, all variables that were not statistically significant were systematically removed from the model. This process was conducted separately for each diagnosis, to ensure that the individual associations between the diagnoses and the causal variables was comprehensively modelled. The same process was used to separately


Environmental Demands
Appraisal of Demands
Perceived Stress
Benign Appraisal
Negative Emotional Responses
Physiological or Behavioural Responses
Increased Risk of Physical Disease
Increased Risk of Psychiatric Disease

apply the model to each diagnosis, so only two diagnoses will be discussed in detail to provide an illustration of the process. The two diagnoses that are used to illustrate the process below (circulatory disease and diabetes) were chosen because these two diagnoses have been frequently associated with the stress process in the literature (Friedmand and Rosenman, 1974; Eysenk, 2000; Change et al, 2002; Georges et al, 1993).

Table 33 shows an example of the analysis conducted for the circulatory disease group of diagnoses. Only the significant exogenous and latent measures which were entered into the model at each step are shown. The exogenous measures or risk factors in the model (community, gender, age, education, activity level and BMI) were added into the SEM model to determine their direct effects in the first step. The second step included the addition of the major life events, and the third step added the social and psychological measures of the appraisal process. The fourth step included the addition of self-perceived stress and arousal, and the final step in the analysis was the addition of the negative emotional responses. Only those causal associations with a t-test statistic of greater than |2.0| were considered significant enough to report.

The first step suggested that community was an important factor in the development of a circulatory disease (.224), as was the identification of a pre-existing chronic disease (.091), and increased activity reduced the likelihood of a subsequent diagnosis of a circulatory disease (-.103). These three risk factors remained significant after adding the effects of exposure to major life events to the model in the second step. Only two major life events had an effect on the diagnosis of a circulatory disease: respondents who had experienced an improvement in finances in the previous year were more likely to be diagnosed with a circulatory disease in the subsequent year (.131), and respondents who had an illness or injury in the year prior to the study were less likely to be diagnosed with a circulatory disease in the subsequent year (-.096).

The third step, corresponding to the appraisal step in the stress process defined in Cohen, Kessler and Gordon's model, was the addition of the social and psychological measures used by the individual in the appraisal process to determine if the environmental demands exceed their capacity to cope. All four measures of social and psychological characteristics were added to the model in this step, but only social disconnection was identified as having a significant causal effect on subsequent diagnosis of a circulatory disease (.294). The addition of these measures resulted in the removal of three of the measures previously included in the model: illness or injury, chronic disease diagnosis and community were no longer significant factors in the diagnosis of a circulatory disease after the effects of social disconnection were controlled. The size of the slope of diagnosis on activity level increased when the effects of social disconnection were controlled (from -.092 to -.158), indicating that after controlling for the effects of belief in social disconnection, the effects of activity on diagnosis of a circulatory disease were even greater. The effects of experiencing an improvement in finances also remained a significant factor in the development of this diagnosis.

The subsequent addition of the measures in the remaining steps did little to add to the explanatory power of the model.

Table 34 shows an example of the step by step analysis conducted for the diagnosis of diabetes. Only those causal associations with a t-test statistic of greater than |2.0| were considered significant enough to report and are shown in the table. The exogenous measures or risk factors in the model (community, gender, age, education, activity level and BMI) were added into the SEM model to determine their direct effects in the first step.

The analysis of the first step indicates that the individual's body mass index (BMI) was an important factor in the development of diabetes (.150): people who were overweight were more likely to be diagnosed with diabetes following the study than people who had a lower body mass index. None of the other measures were statistically significant.

The effects of the experience of major life events on subsequent diagnosis of diabetes were added to the model in the second step. Illness or injury of someone close was the only major life event that had an effect on the subsequent diagnosis of diabetes (.129).

The third step in the analysis was the addition of the social and psychological measures used by the individual in the appraisal process to determine if the environmental demands exceed their capacity to cope. All four measures of social and psychological characteristics were added to the model in this step, but only social disconnection was identified as having a significant causal effect on subsequent diagnosis of diabetes (.138). The addition of the measures of social and psychological resources increased the significance of two of the measures of risk factors: after controlling for the effects of belief in social disconnection, age had a significant positive effect on diagnosis of diabetes (.128) and previous diagnosis of a chronic disease had a negative effect on diagnosis of diabetes (-.100). In other words, after controlling for the effects of belief in social disconnection, older people were more likely to be diagnosed with diabetes, and people with a previous diagnosis of a chronic disease were less likely to be diagnosed with diabetes. The effect of an illness or injury of someone close was no longer statistically significant.

As we saw with the analysis of circulatory diseases, the addition of the remaining measures in the final two steps of the analysis slightly altered the size of the slopes of the existing measures, but the measures of self-perceived stress, arousal, and negative emotional response did not have a statistically significant effect on the diagnosis of diabetes. It is important to note that social disconnection had a significant effect on both these diagnosis categories, and that it was the only measure in the social psychological portion of the stress process model that was significant.

Table 33: Five Steps in SEM Analysis of Direct Effects of Latent and Exogenous Variables on Circulatory Disease

Measure	Step One: Risk Factors		Step Two: Major Life Events		Step Three: Psych and Social Measures		Step Four: Self-Perceived Stress		Step Five: Negative Emotional Responses	
	β	t-value	β	t-value	β	t-value	β	t-value	β	t-value
Community	.224	4.947	.226	4.973						
Gender										
Age										
Education										
Chronic disease	.091	2.027	.113	2.447						
Activity level	-.103	-2.373	-.092	-2.099	-.158	-2.389	-.168	-2.437	-.180	-2.877
BMI										
Lost job or been unemployed										
Work-related difficulties										
Got married										
Separated or divorced										
Quit or retired										
Illness or injury			-.096	-2.139						
Death of someone close										
Trouble with spouse										
Improvement in finances			.131	3.001	.134	2.041	.140	2.088	.157	2.501
Strike or laid off										
Financial problems										
Arrival of baby										
Someone moved in or out										
Started working/changed jobs										
Illness/injury of someone close										
Changed residence										
Promotion at work										
Psychological resources										

Measure	Step One: Risk Factors		Step Two: Major Life Events		Step Three: Psych and Social Measures		Step Four: Self-Perceived Stress		Step Five: Negative Emotional Responses	
	β	t-value	β	t-value	β	t-value	β	t-value	β	t-value
Social contact										
Anomia/alienation										
Social disconnection										
Self-perceived stress					.294	2.640	.254	2.315	.288	2.925
Arousal										
Depression										
Tension										
Anger										
Confusion										
Valence										

Table 34: Five Steps in SEM Analysis of Direct Effects of Latent and Exogenous Variables on Diabetes

Measure	Step One: Risk Factors		Step Two: Major Life Events		Step Three: Psych and Social Measures		Step Four: Self-Perceived Stress		Step Five: Negative Emotional Responses	
	β	t-value	β	t-value	β	t-value	β	t-value	β	t-value
Community										
Gender										
Age					.128	2.589	.109	2.174	.112	2.233
Education										
Chronic disease					-.100	-2.158	-.094	-1.986	-.107	-2.258
Activity level										
BMI	.150	3.278	.149	3.236	.164	3.549	.164	3.493	.149	3.176
Lost job or been unemployed										
Work-related difficulties										
Got married										
Separated or divorced										
Quit or retired										
Illness or injury										
Death of someone close										
Trouble with spouse										
Improvement in finances										
Strike or laid off										
Financial problems										
Arrival of baby										
Someone moved in or out										
Started working/changed jobs										
Illness/injury of someone close			.129	2.855						
Changed residence										

Measure	Step One: Risk Factors		Step Two: Major Life Events		Step Three: Psych and Social Measures		Step Four: Self-Perceived Stress		Step Five: Negative Emotional Responses	
	β	t-value	β	t-value	β	t-value	β	t-value	β	t-value
Promotion at work										
Psychological resources										
Social contact										
Anomia/alienation										
Social disconnection					.138	2.128	.163	2.199	.147	2.080
Self-perceived stress										
Arousal										
Depression										
Tension										
Anger										
Confusion										
Valence										

The same process of step by step addition of the measures of the components of the model was completed for the other diagnoses. The significant exogenous and latent measures for each diagnosis are included in Table 35.

Neoplasm (including all types of cancers) is negatively associated with arousal (-.095), and breast cancer is positively directly affected by body mass index (.100) and changing jobs (.124), but is not affected by arousal or any of the other social psychological predictors in the model. The direct effect of illness of someone close and diabetes is no longer evident, indicating that the effects of external events on development of diabetes are mediated by the social psychological predictors in the model. Gender (.101), valence (.185), psychological resources (.118) and social mastery (.166) are all positively associated with diagnosis of diabetes, but anger is not. Body mass index also has a significant effect on diagnosis of diabetes, as expected. Diagnosis of a blood disease is not affected by any of the external demands, but is affected by social mastery (.138). Gender (.124), arousal (.227) and social mastery (.289) are positively associated with diagnosis of a mental disorder. Two external events: illness or injury of someone close (-.114) and job loss (-.114) also have a direct effect on diagnosis of a mental health disorder. Diagnosis of a disease of the nervous system is affected by social mastery (.289) and is directly negatively affected by experiencing financial problems (-.142) having someone move in or out of the home (-.109) and death of someone close (-.094). This means that people who experienced these events were less likely to be diagnosed with a disease of the nervous system. Improvement in finances (.141) was positively associated with a disease of the circulatory system (experiencing the event increased the likelihood of getting diagnosed with a circulatory system disease), and social mastery (.223) was also positively associated with this diagnosis (people with a strong belief in mastery of the social environment were less likely to receive this diagnosis). Activity level, as expected, was negatively associated with a diagnosis of a disease of the circulatory system (-.130).

Gender (.136) and social mastery (.186) are positively associated with the diagnosis of ischemic heart disease, and valence (-.093) and anger (-.089) both negatively affect this diagnosis. This suggests that, contrary to other findings, people who express more anger are less likely to be diagnosed with ischemic heart disease. Death of someone close was positively associated with diagnosis of cardiac dysrhythmias (.130) as was gender (.121). Diagnosis of a cerebrovascular disease was positively associated with arousal (.119) and with psychological resources (.107). A diagnosis of a disease of the arteries was negatively associated with anger (-.097), but was positively associated with experiencing illness of someone close (.135) or a job promotion (.156).

Diagnosis of a disease of the respiratory system was not associated with any of the social psychological measures in the model but was positively associated with experience of divorce (.132) strike (.107) and moving (.101). Pneumonia was positively associated with experiencing financial problems (.111) and anger (.117) but negatively associated with gender (-.095). Diagnosis of chronic bronchitis was not directly affected by any of the external events, but was positively associated with psychological resources (.129) and with social mastery (.101). Diagnosis of COPD was positively affected by valence (.397), psychological resources (.545) and retirement (.107). The association between these social and psychological measures and the diagnosis of COPD is not only significant, but also relatively large. Diseases of the digestive system are positively associated with social mastery (.120) and having someone move in or out of the home (.105). Diseases of the genitourinary system are not affected by any of the variables in the model, but complications of pregnancy (a subset of the diagnoses in this chapter) are positively affected by job loss (.134). Diagnosis of a disease of the musculoskeletal system is also positively affected by job loss (.099) but is negatively affected by arousal (-.137). Ill-defined conditions are not associated with any of the variables in the model. Injury is positively affected by valence (.206), psychological resources (.187), and anger (.126). Diagnosis of hypertension is negatively affected by arousal (-.105), and activity level (-.110) and is positively affected by body mass index (.182). Diagnosis of a pulmonary disease is positively affected by valence (.225) and negatively affected by psychological resources (-.284).

Table 35: Direct Effects of Latent and Exogenous Variables on Disease Diagnoses

Diagnosis	Comm unity	Age	Gender	BMI	Activity Level	Low psych resources	Social disconnect	Arousal	Valence	Anger	Stress	Events	
Neoplasms													
Breast cancer				.100								Change job	.124
Endocrine/immune													
Diabetes		.112	.096	.149			.147						
Blood diseases							.138						
Mental disorders	.245		.124				.289	.227				Someone sick Lost job	-.114 - .114
Nervous system	.177						.198					Financial problems Someone moved in	-.142 -.109
Circulatory system					-.180		.288					Financial impr	.157
Ischemic heart disease		.154	.136				.186						
Cardiac dysrhythmias			.121									Death	.130
Cerebrovascular disease													
Arteries												Someone sick Job promotion	.135 .156
Respiratory system												Divorce Strike Moved	.132 .107 .101
Pneumonia			-.095							.117		Financial Problems	.111
Chronic bronchitis						.129							
Other chronic obstruction		-.231				.545			.397			Retire	.107
Digestive system	.160										.144	Someone moved in Strike	.105 .097
Genitourinary system													
Complications of Pregnancy												Lost job	.134
Musculoskeletal system	.162							-.137				Lost job	.099
Ill-defined conditions													
Injury	.172					.187			.206	.126			
Hypertension	.135			.167	-.105			-.121					
Pulmonary Disease						.284			.225				

Table 36 shows the number of events that either directly or indirectly affected a diagnosis. Only a few diagnoses are unaffected either directly or indirectly by the major life events. The indirect effects of major life events identified in the table reflect the effects through one or more of the measures of the stress process, and some events, such as lost job, affect the diagnosis through more than one endogenous variable.

Of particular significance to this discussion and the test of the first hypothesis is the fact that a number of events have a direct causal effect on some of the diagnoses, even after controlling for the social and psychological mediating variables in the model. Even more interesting is that controlling for the mediating variables in the model demonstrates increased importance of some events that were previously unassociated with a particular diagnosis. For example, diagnosis of a disease of the nervous system was only affected by financial problems in the simple model, but the final model indicated that, after controlling for the effect of the belief in social disconnection, the causal effect of financial problems, having someone move into the home, and the death of someone close on the diagnosis of a disease of the nervous system became statistically significant.

The significance of the causal effects of belief in social disconnection on health diagnosis indicates that this is an important factor in the stress process model. Although belief in social disconnection had a causal effect on arousal, it was unassociated with any of the other endogenous measures in the model, yet was a causal factor in the development of a number of different diagnoses.

Table 36: Diagnoses Directly or Indirectly Affected by One or More Events

Diagnosis	Direct Effect	Indirect Effect
Neoplasms		
Breast cancer	1 (change job (+))	
Endocrine/immune		
Diabetes		3 (someone ill (+); trouble with spouse (+); someone moved in (+))
Blood diseases		3 (someone ill (+); trouble with spouse (+); someone moved in (+))
Mental disorders	2 (someone sick (-); lost job (-))	6 (someone ill; trouble with spouse; someone moved in; financial improvement; financial problems; job promotion)
Nervous system	2 (financial problems (-); someone moved in (-))	3 (someone ill (+); trouble with spouse (+); someone moved in (+))
Circulatory system	1 (financial improvements (+))	3 (someone ill (+); trouble with spouse (+); someone moved in (+))
Ischemic heart disease		3 (someone ill (+); trouble with spouse (+); someone moved in (+))
Cardiac dysrhythmias	1 (death (+))	
Cerebrovascular disease		
Arteries	2 (someone sick (+); job promotion (+))	
Respiratory system	3 (divorce (+); strike (+); moved (+))	
Pneumonia	1 (financial problems (+))	5 (lost job (+); trouble with spouse (+); strike (-); someone ill (+); death (-))
Chronic bronchitis		4 (lost job (+); illness (+); financial problems (+); retirement (+))
Other chronic obstruction	1 (retire (+))	7 (lost job (+); illness (+); financial problems (+); retirement (+); divorce (-); work problems (-); trouble with spouse (-))
Digestive system	2 (someone moved in (+); strike (+))	
Genitourinary system		
Complications of Pregnancy	1 (lost job (+))	
Musculoskeletal system	1 (lost job (+))	4 (financial improvement (-); financial problems (-); someone ill (-); job promotion (-))
Ill-defined conditions		
Injury		10 (divorce (-); lost job (+); trouble with spouse (-); work problems (-); illness (+); financial problems (+); strike (-); change

Diagnosis	Direct Effect	Indirect Effect
		jobs (+); death (-))
Hypertension		4 (financial improvement (-); financial problems (-); someone ill (-); job promotion (-))
Pulmonary Disease		7 (lost job (+); illness (+); financial problems (+); retirement (+); divorce (-); trouble with spouse (-); work problems (-))

The final step in the analysis was to consider a number of diagnoses into a single SEM equation. The evidence of a latent measure of disease required to support Selye's hypothesis of a non-specific response to disease was not substantiated by the analysis. The pattern of associations between disease and the indicators of the stress process remained constant when several diagnoses were added to the equation, and there was no evidence of a latent variable in the modification indices.

SUMMARY

Overall, the analysis showed that a selection of the major life events had a direct effect on the subsequent diagnosis of a health condition, and several of the major life events also had an indirect effect through the mediating variables in the model. Most of the diagnoses were affected by at least one measure in the stress process model.

Structural equation modelling helped to clarify the causal pathway through which the major life events and other environmental demands affected diagnosis. The analysis also validated the use of arousal as a measure in the stress process, and also provided support for the use of the measure of social disconnection, demonstrating it's effect on health outcome.

CHAPTER 6: DISCUSSION OF THE RESULTS

As stated at the outset, the objective of the analysis discussed above was to determine whether the response to external events or stressors could be characterised as a general non-specific response, or if the response to external stressors is in fact mediated through a constellation of social and psychological factors to result in very specific physiological changes.

The specific questions to be addressed were:

1. Can the response to external events be characterised as non-specific? That is, do the external environmental demands affect a wide variety of diagnoses, independently of the social or psychological mediators in Cohen's model?
2. Can the stress response (Selye's alarm stage) be measured?
3. What is the relative significance of the social and psychological mediators in the model? and
4. How do the social and psychological responses to stressful events affect health outcomes?

CHARACTERISING THE RESPONSE TO STRESS AS NON-SPECIFIC

As mentioned above, the hypothesis to be tested by the first question proposed that environmental demands such as major life events cause a non-specific physiological response, both independently of and mediated through the social or psychological resources available to the individual. The operationalisation of the hypothesis suggested that a non-specific response would be manifested by significant direct causal associations between environmental demands or events and a number of different health conditions, independently and in addition to the indirect causal associations through the social and psychological mediators. On the other hand, if environmental demands are only associated with one or two different diagnostic categories, that would imply that the response to environmental demands results only in specific physiological changes.

The conditions required to support the hypothesis were supported by the analysis of individual diagnoses: a number of the major life events included in the model had significant direct causal effects on a variety of diagnoses, independent of the social and psychological responses to those events (see Table 36). Almost every diagnosis was directly affected by one or more events, independent of the effects of the events through the mediating social and psychological measures. In addition, a large number of major life events had an indirect effect through the social and psychological mediators. Most of the diagnoses were affected either directly or indirectly by the major life events. For example, ten events had a statistically significant indirect causal effect on diagnosis of an injury subsequent to the study period; three events had a direct causal effect on a diagnosis of a respiratory system disease; one event had a direct effect and seven events had an indirect effect on diagnosis of chronic obstructive pulmonary disorder (COPD); and two events had a direct effect on a diagnosis of a disease of the arteries (such as atherosclerosis).

Some diagnosis categories were not affected by any of the events, either directly or indirectly through the psychological or social measures in the model. Neoplasms as a group were not affected by any external events, although a diagnosis of breast cancer was directly affected by one major life event. Disorders of the endocrine system were also unassociated with any life event, while diabetes (a specific form of a disorder of the endocrine system) was affected indirectly by three major life events. Cerebrovascular disease, disorders of the genitourinary system as a group of diagnoses, and ill-defined conditions were all unaffected by the major life events.

The SEM analysis of the model using individual events provided some support for Selye's argument that environmental demands have an effect on health, but did not provide support for Selye's concept of a non-specific response. The pattern of associations between each disease and the social psychological indicators of the stress process that were found when the analysis only considered a single diagnosis remained constant when several diagnoses were added to the equation, and there was no evidence of a latent variable reflecting disease in the modification indices.

Further, the analysis did not provide any support for combining the events into a scale. Combining measures of major life events into a single score is considered an appropriate and necessary method for creating a single measure of external environmental demands on the individual, as proposed originally by Holmes and Rahe (1967). This method assumes that the cumulative score is an accurate measure of the level of stress. However, as the analysis shows, grouping the events into a scale disguises the association between specific types of major events and their impact on certain types of health outcomes. For example, basic correlation analysis showed evidence of an association between experiencing financial problems and a subsequent diagnosis of COPD, but this association was not evident when the events were combined into a scale. This loss of specificity was evident across all the scale measures, because very few of the specific diagnoses that were associated with one or another of the events were significant when those events were combined into a scale. Further, the correlation analysis indicated that very few diagnoses were associated with any of the scales, which would lead to the conclusion that events were not an important factor in disease. However, the SEM analysis indicates that a number of events are a significant factor in the development of a disease. The method of combining events into a scale disguises the relationship between individual events and disease. Keeping the analysis at the level of individual events can therefore lead to a richer understanding of the mechanisms at work than can be discerned by combining the events into a scale.

It has been argued in the literature (e.g. Lepore, 1995) that the specific constellation of life changes associated with a particular event are the more likely cause of subsequent health problems. Evaluation of the individual events has lead to some significant findings, such as the relative importance of social contacts and social support. The current analysis provided further support for this approach. For example, illness or injury of someone close and job loss in the year prior to the study both had a negative effect on the subsequent diagnosis of a mental health disorder in the year following the study period. These two events seem to contradict the theory, but more likely reflect the need to understand the events in greater detail to determine their impact on health outcomes: illness or injury of someone close requires that the respondent who identifies this as a major event in their lives must have close enough social contacts (and thereby the necessary social support) in order to recognise the event as affecting them. The total number and frequency of social contacts was not a significant factor in the development of disease in the current analysis, but the analysis did not include the evaluation of the possibility that having one very close friend may be a more significant factor in the development of disease. The analysis also shows that the causal effect of illness or injury to someone close is negative after controlling for gender, somewhat contradictory to the findings of Turner and Marino (1994), who found that women were more likely to be affected by illnesses to other people in their social circle. However, Turner and Marino were measuring the effect of social contacts on perceived stress, which is not indicative of disease.

The negative causal effect of job loss on a mental health diagnosis is easily explained if one considers the fact that leaving an unrewarding or dissatisfying job could actually reduce stress by removing the source of dissatisfaction.

The lack of association between most of the positive life events and health outcomes replicated the lack of findings in the literature (e.g. Brown and Harris, 1978). Although Selye suggested that positive life events also cause stress, few researchers have been able to provide evidence of this association. However, two positive life events (improvements in financial situation and getting a job promotion) did have a significant effect on heart health outcomes. This result is easily understood within the context of stress theory, because both events are associated with increased responsibilities. These two significant causal effects demonstrate the problems with grouping all events, or even just all positive events, into a single measure, and demonstrates why the approach to analysis taken by most researchers of grouping positive life events into a single scale is seldom successful.

An alternative approach to measuring only the impact of major life events on disease is the consideration of the stress of everyday life through the measurement of more minor stressors that occur on a daily or weekly basis called 'hassles'. The importance of these hassles was hinted at by Selye (1956) and was later expanded upon by other researchers (e.g. Delongis, Folkman and Lazarus; 1988). The importance of minor stressors was evaluated in the current analysis with the Weekly Stress Inventory (WSI) developed by Brantley (in Zalaquett & Wood; 1998).

The Weekly Stress Inventory was not correlated with any diagnoses, and was therefore removed from the causal analysis component of the study. The WSI score was correlated with some of the events scales, suggesting that people who have experienced those major life events were more likely to identify minor daily hassles as stressful, and this association may account for associations between weekly stressors and health outcomes found by other researchers (e.g. Brantley, 1998; Delongis, Lazarus, and Folkman, 1988) who included only an assessment of the daily or weekly stressors and didn't account for the unmeasured effects of major life events. At a minimum, the lack of association between the weekly stress inventory and any health diagnoses indicates that complaints of stress or daily hassles do not equate with physiological changes that may cause a change in health.

Although the WSI incorporates appraisal of the event into one of the two scoring methods, it could be argued that all the measures used for the scale reflect a pre-existing level of anxiety which causes the individual to find everyday events more stressful, but that the scale does not measure events that are stressful enough to cause health problems. The correlation analysis supports this argument because the count of events was significantly associated with self-perceived stress, replicating the findings in the literature that the number of hassles identified on the weekly stress inventory is associated with the level of self-perceived stress. On the other hand, the correlations between these two measures could actually reflect the effect of self-reported stress level on the responses to the WSI.

Although small, the significant associations between the WSI scores and the measures of arousal and the negative emotional responses that were found in the correlation analysis provide some support for the theoretical approach to the measurement of arousal. However, the lack of association with any health event is evidence that the WSI scale is not very useful for examination of the impact of environmental demands on health outcomes. The WSI tool may indeed function like a measure of arousal or self-perceived stress, but daily hassles are not a significant cause of stress themselves, and when the level of arousal was controlled, the WSI score was no longer significantly associated with anything.

Overall, the analysis indicated that major life events are associated with disease, both directly and indirectly through social and psychological mediators. The analysis also indicated that combining events into scales obscured the impact of events on health, and measuring the effect of minor stressors did not improve the predictability of the stress model. Finally, we can conclude from the SEM analysis that there is a no evidence general stress response to environmental demands that results in changes in health. This finding increases the importance of evaluating the common themes or impacts on an individual's life resulting from a major life event, with the goal of determining the mechanisms through which major life events might affect one's health.

MEASURING THE STRESS RESPONSE

Two measures (self-perceived stress and arousal) were proposed as possible measures of the alarm stage of the stress response identified by Selye and included in Cohen, Kessler and Gordon's model as perceived stress. The measure of self-perceived stress is the most commonly used measure of stress[12], and the measure of emotional arousal, derived from a scale of discrete emotions (Bradburn, 1969), was proposed as an alternative.

The correlation analysis of self-perceived stress with diagnosis only identified two diagnoses affected by stress: a disease of the circulatory system and a disease of the digestive system. This replicates the findings in the literature that stress affects heart health (e.g. Chang et al, 2002) The proposed alternative measure of stress called arousal was also only correlated with two diagnoses: hypertension and an other (unclassified) condition. If the analysis is restricted to correlation analysis, this would indicate that neither measure should be considered valid for an analysis of the stress process and its effects on health outcome. The SEM analysis provided further support for this conclusion.

Some components of the model of the stress process proposed by Cohen, Kessler and Gordon were supported by the SEM analysis of the latent measures, but the analysis indicated that self-perceived stress was not a significant factor in the model. The analysis indicated that the measure of self-perceived stress was, in fact, only affected by valence, and had a small although statistically significant effect on the individual's belief in their psychological resources. There was a reciprocal effect of valence on self-perceived stress and self-perceived stress on valence, but the comparison of the size of the standardized slopes indicates that valence had a greater effect on self-perceived stress. Therefore, we can conclude that evaluating the stress process model using self-perceived stress as the outcome or dependent variable is not a sufficient test of the impact of events on health, because it is not associated with subsequent diagnosis, nor is it an outcome of the appraisal process. Self-perceived stress appears to function more as an indicator of complaint than as a measure of an assessment of the actual physiological 'fight-or-flight' processes associated with the stress response as it was originally intended to be. As mentioned earlier, the correlation between the responses to the weekly stress inventory and the measure of self-perceived stress (Table 20) indicates that these two measures reflect a level of awareness and complaint, but are not an effective or objective measure of elevated response to external stressors.

---

[12] For example, see http://www.statcan.ca/start.html, 2004

Although the structural equation model analysis places the measure of arousal at the end of the process of appraisal and response, the social and psychological measures used in the appraisal process had a negative effect on arousal, the opposite direction to what was expected. The lack of belief in the availability of psychological resources has a negative direct effect on arousal and the same was true for social disconnection - respondents who did not have any confidence in either their own psychological resources, nor in their ability to control their social environment were less aroused. These findings replicate the findings in the literature (e.g. Pearlin and Schooler, 1978) that low confidence in psychological and social resources in combination with stressful events results in symptoms of sub-clinical depression (evident in this analysis in the form of low arousal and fewer expressions of positive emotions, and the significant correlations between arousal and the measure of sub-clinical depression). However, if arousal was measuring the alarm stage of response to stress – equivalent to the "perceived stress" step in Cohen, Kessler and Gordon's stress process model, lack of belief in the availability of psychological resources and lack of belief in support from the social community should have both had a positive effect on arousal; in other words, the appraisal of weakness in these two areas should have increased the individual's perception of the stressfulness of the situation and increased the level of emotional volatility, rather than decreasing it. On the other hand, the measure of arousal used for the current effect of arousal on health may not be linear, but this is difficult to test with structural equation modelling techniques.

Arousal had a relatively large positive effect on subsequent diagnosis of a mental health disorder, and a negative effect on a diagnosis of hypertension and a disease of the musculoskeletal system – in other words, low levels of arousal (i.e. apathy or lethargy) were associated with the latter two conditions. The causal effect of arousal on a diagnosis of hypertension indicates that people who are more expressive of emotions and outwardly aroused are less likely to develop hypertension, although this is contrary the findings in the literature (e.g. Chang et al, 2002). The causal effect of arousal on a disease of the musculoskeletal system is more difficult to explain, unless one considers that the level of arousal may be an early warning sign of this type of illness. Many of the diseases in this chapter are degenerative diseases that develop over a long period of time, much longer than the single year included in the study. Decreased activity levels and lower levels of arousal are typical responses to early symptoms of this type of disease, and the measure of arousal used for the study may reflect early symptoms.

Based on the analysis of the latent model and the minimal direct effects of either self-perceived stress or arousal on subsequent diagnosis, it is clear that neither measure could be considered a valid measure of Cohen's "perceived stress" as an outcome of the appraisal process. For either measure to be considered a valid surrogate measure for the stress process (including experiencing external environmental demands, evaluating their impact through appraisal or resources, and becoming aroused or 'stressed'), the analysis of the latent measures shown in Figure 4 should have shown these two measures as being significantly affected by the measures of social and psychological resources, and all the measures as affecting valence. However, the analysis indicated different directional pathways than those predicted by the model; neither measure was associated with the measures of appraisal to sufficiently support the theory and neither measure was a significant causal factor in the development of disease.

THE RELATIVE SIGNIFICANCE OF THE MEDIATORS

The third question to be addressed by the study was to clarify the relative significance of the mediators in the model. This question was addressed by the factor analysis of the latent measures in the model which defined the causal structure of the social and psychological mediators. The analysis did not support the model of the stress process as defined by Cohen, Kessler and Gordon. As was evident from the model described in Figure 4, the analysis did not place the measures of negative emotional response at the end of the appraisal process (i.e. in response to increased levels of stress or arousal), but produced a rather more complex process than that described by Cohen, Kessler and Gordon.

Valence acted as a precursor rather than an outcome measure in the model. Rather than functioning as a negative emotional response as originally proposed, valence had a direct negative effect on all the other social and psychological measures in the model and as such acted as a pre-existing condition or personality-type variable describing the individual's general approach to life.

The individual's confidence in their psychological resources had a negative direct effect on valence: people who lack confidence in their own psychological resources were less likely to express positive emotions. There was also a reciprocal relationship between valence and lack of belief in psychological resources, but comparison of the size of the standardised slopes in this case indicates that low psychological resources has a greater effect on valence than valence had on low psychological resources. Valence also had a negative effect on belief in social disconnection: people who expressed fewer positive emotions were more likely to express feelings of social disconnection. This analysis reflects the findings in the literature that people who lack confidence in their own psychological resources are more likely to be depressed (and therefore express more negative than positive emotions) but the causal priority is opposite to the findings in the literature (Pearlin and Schooler, 1978) – that is, unhappy people are more likely to express lack of confidence in themselves.

The magnitude of the standardised slopes indicates that valence exerted a greater effect on anger than anger exerted on valence (happier people, or people who express a wider range of positive emotions, are less likely to express anger as a predominant emotion). Overall there was little support for the influence of anger in the stress process (see Figure 4) that has been found by other researchers (Chang et al, 2002), because anger was not an integral part of the stress response process outlined by Cohen, Kessler and Gordon, nor was it a causal factor in a significant number of diseases.

The analysis suggested that valence is a personality-type variable, fundamentally influencing the level of expressed anger, the belief in social disconnection and the belief in psychological resources, and that there is a reciprocal effect with lack of belief in psychological resources. In other words, individuals who expresses predominantly positive emotions are less likely to express anger, less likely to express lack of confidence in social and psychological resources and less likely to be aroused; individuals who express fewer positive emotions will express more anger, lack confidence in social and psychological resources and are more likely to be aroused. This finding brings much of the literature on the effects of social and psychological variables on mental health into question. Most of the literature on this association uses some form of depression scale (roughly equivalent to valence) as an outcome measure, and applies the model to data collected at one point in time. However, the current analysis indicates that the causal pathway operates in the opposite direction: unhappiness or sub-clinical depression acts to decrease belief in psychological and social resources, thereby decreasing belief in self-efficacy.

Social contact was defined by other researchers (e.g. Kessler and McLeod, 1984; Turner and Marino, 1994), as an important mediating factor in the stress process, and the correlation analysis replicated this finding: the measure of social contact was significantly correlated with self-perceived stress. However, as discussed above, the measure of self-perceived stress is not a good measure of the actual stress level or the association between stress and disease, so the association between social contact and self-perceived stress is of little relevance. The correlation analysis also replicated the finding in the literature that social contact is associated with sub-clinical measures of depression, but again, this does not translate into a clinical level diagnosis, so is not relevant to the evaluation. Although this measure and the measure of anomia and alienation were not fully modelled in the structural equation model, they were included in each of the steps until the final analysis when the non-significant measures were removed, and neither measure was associated with health outcomes.

The correlation analysis indicated that, of all the measures of social resources, only social disconnection was correlated with any of the diagnoses. The structural equation analysis also demonstrated that an individual's belief in their ability to control their own social environment has an effect on a number of health conditions, including diabetes, blood diseases, mental health disorders, diseases of the nervous and circulatory systems and ischemic heart disease. The addition of social disconnection to the SEM model in step three (see Table 33) reduced the statistical significance of some of the other measures, indicating that those measures were not important when the effects of social disconnection were controlled. The correlation analysis indicated that community was a significant factor in the development of a number of diagnoses, but the SEM analysis indicated that feelings of disconnection from the community accounted for the effect. This analysis suggested the possibility of interaction between community and social disconnection, but a multiple regression evaluation of the interaction (not shown) proved that this was not the case.

The two measures that had significant associations in the model (social disconnection and the belief in psychological resources) reflect a general approach to life that assumes that most events are beyond the direct control of the individual, and this attitude has an effect on health outcomes. The two measures also operate independently, indicating that they measure distinct and separate attitude and coping dimensions - individuals may believe that they have the personal psychological resources to address any environmental demands, while still believing that the social community is hostile and that they are a victim of the whims of society.

The development of the social disconnection construct was loosely based on the measures developed by Pearlin and Schooler (1978), but was intended to reflect a somewhat different approach to personal and social empowerment than Pearlin and Schooler initially defined. Pearlin and Schooler's original measure focused on the individual, and their belief in their own personal power to have an effect on the social environment, whereas the measure of social disconnection used for the current analysis is more general, and reflects an attitude about society as a whole, and the role of the individual within that arena. Srole (1956) developed a measure to reflect this dimension, but his scale was at a higher level of abstraction, measuring attitudes about society in general. The individual indicators used to measure social disconnection in the current study are worded to reflect a sense of disenfranchisement and marginalization from the community - not the impressions of society as a generic construct, but the actual community in which the individual is situated. The measures are very different from the more general impressions and global assertions Srole used to develop the anomia scale – the measures used for the social disconnection scale reflect a more salient belief in the attitudes of the local community in which one lives, and which has the very real probability of affecting one's life. The significance of belief in social disconnection on the subsequent diagnosis of disease has not been identified in the literature to date. Significantly, social disconnection was associated with more diagnoses than any other measure in the model, indicating that these feelings of marginalization have a greater impact on health outcomes than previously recognized.

However, these results need to be further evaluated, because the measure of social disconnection used for the current analysis was not very well defined and had low scale reliability. On the other hand, the SEM process is designed to account for poor scale reliability, by using factor analysis to extract the variation common to the underlying dimension, and using that latent variable for the subsequent regression analysis.

Although each of the measures of the stress process was associated with at least a few diagnoses, the analysis did not provide unqualified support for the model proposed by Cohen, Kessler and Gordon. The analysis indicated that each of the measures of social or psychological resources or responses were important factors in the development of disease, but the association between the measures did not correspond to the linear and progressive stress process model defined by Cohen, Kessler and Gordon. The two measures of personal (social and psychological) resources operated independently of perceptions of stress, and actually reduced the level of arousal. Anger was also independent of the appraisal process, and valence was a fundamental cause of self-perceived stress.

EFFECT OF SOCIAL AND PSYCHOLOGICAL RESPONSES ON DIAGNOSIS

The analysis indicated that all the measures of social and psychological response were causally affected by some of the measures of environmental demands (see Table 32), and that these social and psychological responses in turn have a causal effect on health outcomes. Given these small but statistically significant associations, the analysis supports the argument that there is a process of appraisal of available resources following the experience of a major life event, and that the belief in social and psychological resources moderates the development of disease. However, the analysis did not provide unqualified support for the linear stress process outlined in Cohen, Kessler and Gordon's model.

The analysis identified a number of specific diagnoses that were separately affected by the belief in the availability of social and psychological resources. The correlation analysis indicated that lack of belief in psychological resources was significantly associated with subsequent diagnosis of chronic obstructive pulmonary disease (COPD) and bronchitis, and the structural equation model identified an association between lack of confidence in psychological resources and chronic bronchitis, COPD, injury and pulmonary disease.

As mentioned above, social disconnection was a causal factor in the development of more diseases than any other measure: diabetes, blood disorders, mental health disorders, diseases of the nervous and circulatory systems, and ischemic heart disease were all affected by feelings of social disconnection.

The measures of stress (arousal and self-perceived stress) were not very important factors in the development of disease: only mental disorders were affected by increased levels of arousal, and injury and hypertension were affected by low levels of arousal while self-perceived stress was only a factor in the development of a digestive disorder. This latter finding is particularly interesting given the early associations between stress and digestive system problems found in the literature, and the subsequent abandonment of this line of study. Although the analysis did not provide any support for using the measure of self-perceived stress as an indicator of physiological stress, the statistically significant effect of the measure of stress on digestive system disorders deserves further analysis. The measure of self-perceived stress may in fact be indicative of a physiological change in the digestive system that popular nomenclature and custom informs the individual to interpret as stress, but which is, in fact, an early warning symptom of disease.

Only a few specific diagnostic groups were associated with the measures of negative emotional response, and these were independent of the level of arousal or other measures of the appraisal process. For example, anger increased the likelihood of diagnosis of pneumonia and injury, while valence was positively associated with COPD, pulmonary disease, and injury. Individuals who expressed more positive emotions than negative emotions were more likely to be diagnosed with these three conditions. In general, however, the analysis did not provide overwhelming support for the findings in the literature that anger or negative emotional response is an important causal factor in health. On the other hand, the lack of association may result from the method of grouping the diagnoses, rather than being an actual reflection of the association between anger or negative emotions and development of disease.

It is important to note that the use of physician diagnoses as a measure of health outcome affects the analysis. Diagnoses are typically recorded after the disease has already developed and the symptoms have become significant enough for the individual to seek professional help. The methodological restrictions applied to the data, including grouping the diagnoses into chapters and removing diagnoses that occurred prior to the study collection period, also have an effect on the associations found by the analysis. These restrictions were purposely very conservative, to ensure that the analysis did not falsely identify relationships that were not strongly associated, and to ensure the order of occurrence followed the causal process. These qualifiers on the analysis indicate that the association between the measures and diagnosis is likely greater than was evident from the analysis.

SUMMARY

Overall the analysis did not provide support for Selye's argument that there is a general response to stressful events that results in many different diagnoses. Although a variety of event had an effect on a variety of diagnoses, the SEM analysis of multiple diagnoses in a single equation indicated the absence of a latent variable of disease. The analysis was also unable to measure the alarm stage proposed by Selye as a phase in the response to stress; arousal may be a good measure of the fight-or-flight response, but there is no evidence that respondents who were aroused were more likely to be diagnosed with a variety of diseases. The analysis provided some qualified support for the stress process model outlined by Cohen, Kessler and Gordon. Some of the social and psychological mediators proposed in the literature and outlined in Cohen, Kessler and Gordon's model had an effect on subsequent diagnosis, but the analysis indicated that the relationship between these measures was significantly more complex than the linear model described by Cohen, Kessler and Gordon. Finally, the measure of social disconnection was implicated in significantly more disease diagnoses than anticipated.

CHAPTER 7: CONCLUSION

The literature on the effects of the stress process on disease is extensive, and the research community appears to have reached a widely adopted consensus that the model outlined by Cohen, Kessler and Gordon reflects the stress process quite accurately.[13] However, the current analysis did not provide unqualified support for that model.

The correlation analysis replicated most of the findings in the literature, and did not add significantly to stress process model outlined by Cohen, Kessler and Gordon, but the SEM analysis of the entire model produced a somewhat different and more complex picture of the process. Despite the large body of literature on stress and the argument that the process has been well defined (Thoits, 1995, Cohen, Kessler and Gordon, 1995), the current analysis indicates that the stress process model is not as accurately and completely developed as previously thought.

The main objective of this study was to determine if the effect of external stressors and the stress response on health could be characterised as non-specific. Two secondary objectives were: to evaluate the viability of measuring the stress response using a measure of arousal; and to evaluate the significance of the individual's perception of society as supportive or harmful in the stress process.

The analysis provides some support for the hypothesis that environmental demands and the individual's sense of control over their environment have an effect on the individual's health, and that the effect of these environmental demands on health outcomes could be characterised as non-specific. Most of the diagnoses considered in the analysis were affected by at least some of the major life events either directly or through the two mediating variables representing appraisal of the social and psychological resources available. Although some of the risk factors were identified as significant causal factors in the development of disease (such as body mass index and activity level), using alternative methods of measuring environmental demands such as the weekly stress inventory did not improve the explanatory power of the analysis.

---

[13] Public health programs aimed at stress reduction are common through North America, because it is widely accepted as fact that stress has an impact on health.

The stress process model proposed by Cohen, Kessler and Gordon was not well supported by the analysis. Although the analysis demonstrated that each of the indicators in the stress process model had a small but significant causal effect on at least one of the diagnosis groups, the analysis did not replicate the linear progressive association between the measures proposed by the model. Self-perceived stress, a measure widely used to measure stress levels, was not affected by lack of belief in psychological or social resources, and was unassociated with diagnosis with the exception of digestive system disorders. Two of the measures of social and psychological resources had an effect on the development of disease, but the effect was direct and independent of either self-perceived stress or the level of arousal.

On the other hand, although the analysis included several measurement tools widely used in the literature, the model may not have been completely or adequately described. There were some commonalities among the major life events that did have an effect on diagnosis, which suggests a common response that was not captured by the analysis.

The study also had the objective of proposing a more valid measure of the stress response labelled arousal, but the analysis did not provide any support for this argument.

It was argued that by measuring the actual level of emotional arousal, the analysis could measure the alarm stage of stress response as proposed by Selye, and thereby identify those health diagnoses that were directly affected by the level of arousal felt by the individual. This definition of the process also more closely approximates the physiological model of the disease development process. However, the analysis found the opposite associations from what were expected: the level of arousal was negatively rather than positively affected by the lack of social and psychological resources, and level of arousal was not implicated in the development of a large number of diseases. As mentioned above, the measure of arousal used for the current analysis may be more reflective of Selye's exhaustion phase, and may therefore have a non-linear effect on disease. The non-linear effects are not easily tested with SEM techniques, so this association requires further consideration in the future.

The causal association between social disconnection and health diagnosis has not been discussed in the literature, and as such the findings were serendipitous, particularly the number of diagnoses with which this measure was associated. The measure of social disconnection used for the current analysis reflects a somewhat different measure of self-empowerment than the measure of psychological resources. Whereas the measure of low psychological resources focuses on personal resources and the wording emphasises the individual (e.g. *I* believe, *I* feel , etc), the measure of social disconnection reflects a more general belief in the ability to have an impact on the social environment beyond the individual, and in a sense, the individual's belief that society cares about what happens to him or her. The causal association of the perception of social disconnection and the subsequent diagnosis of a variety of health conditions demonstrates the importance of feelings of self-empowerment and connection to society, and indicates that this is relatively more important to the disease process than previously thought. Despite the fact that the scale was not well measured and had a low scale reliability, the SEM analysis clearly identified a latent factor, and identified a number of diagnoses that were affected by that latent factor. This finding is important for the development of a programmatic approach to the reduction of stress than hasn't been widely considered. For example, although stress reduction programs have been successful at teaching the importance of health behaviours and the individual's control over their own health, implementation of social programs emphasizing social empowerment and offering methods of connecting to the community might be more successful than simple stress reduction programs.

The analysis was not able to replicate the findings in the literature of the association between social contact and its buffering effects on health outcome (Wheaton, 1985). Although the correlation analysis indicated that increased social contact decreased the amount of self-perceived stress which would thereby replicate basic findings in the literature, social contact was not associated with any diagnosed health condition. There was no evidence of interaction, which also characterises the literature (Wheaton, 1985). The measure of social disconnection developed for this study is clearly a more accurate measure of the effects of social integration than the number and frequency of social contacts.

It is interesting to note that, contrary to theory, individuals who express greater frequency of feelings of anger are not more likely to believe that they have less control over their social environment, nor are they more likely to express confidence in their own psychological resources. This implies that anger is not an expression of frustration about the individual's feelings of ineffectiveness, but is perhaps a more fundamental personality response. Anger did have an effect on some diagnoses, but was not as important as the literature would suggest (Chang et al, 2002). However, the tool used to measure anger, taken from the Profile of Mood States, is not as comprehensive as that used by Chang and may reflect a more transient response than the personality characteristics of consistent anger response identified by Chang.

SUGGESTIONS FOR FURTHER RESEARCH

The analysis identifies a number of challenging questions that require further investigation. For example, the significant associations between social disconnection and disease were surprising, and raises some very interesting questions for further study. The significance in the belief in connection to the local community and the impact of this belief on the stress process has not been identified in the literature, which indicates that this association is worthy of further exploration. Measures of social disconnection have been developed by other researchers (Srole, 1956; Travis, 1993), but have not proven useful for this type of analysis. However, the scale used for the current analysis did not have good reliability so the first step to develop this model further would require some improvements in the measurement tool.

The identification of the significant role of a belief in social disconnection on the disease process would be of interest to researchers working in the field of sociology seeking to understand the role of social marginalization on health as well as public health policy researchers seeking to develop health programs to reduce preventable disease. Previous studies have focused on objective measures of social marginalization, such as socio-economic status or social roles, but this very subjective measure of belief in personal marginalization provides significantly more explanatory power compared to those other measures. Furthermore, the potential physiological changes associated with this worldview may be more easily measurable than previous attempts at measurement of response to anger, etc. Since the measure reflects a general sense of marginalization from the local community, but is not worded to specifically reflect a stage in the stress process, the measure could be applied to a variety of theoretical models in addition to the basic stress process evaluation discussed by the current analysis. As mentioned above, further evaluation of the role of social disconnection in the etiology of disease could lead to development of social programs emphasizing social empowerment and offering methods of connecting to the community. A corollary of this would be the restriction of programs emphasizing community ideals such as traditional family units, which in effect ostracizes individuals who do not meet those ideals.

Selye suggested that the level of stress was not as important to the individual as maintaining equilibrium, and that stressful events affected the individual's health by disrupting that equilibrium. The analysis did not find many significant associations between arousal and diagnosis, although the association with the WSI suggested that the measure of arousal was measuring stress in some form. The measurement of arousal may be more complex than was considered by the analysis. Arousal may reflect two stages of the general adaptation syndrome: the alarm stage *and* the exhaustion stage. As such, the relationship between arousal and diagnosis could be a non-linear relationship, which was not tested by the current analysis and requires further exploration.

The significant association between arousal and musculoskeletal diseases implies that this measure could be used as an early warning mechanism in the detection and diagnoses of these diseases, and warrants further evaluation to improve diagnosis.

The lack of association between only a few diagnosis categories and the events is as important as the large number of significant direct and indirect associations between events and diagnoses because it suggests a potential avenue of research for both stress researchers, as well as researchers investigating the development of disease and potential medical treatment. The comparison of the etiology of the diagnoses which are not associated with any events with the etiology of the diagnoses which are associated with events could, for example, indicate specific physiological process differences between those diseases. These differences in physiological processes could then be used to determine more specifically how these events affect the human body, as well as provide some clarification to the understanding of the developmental process of disease.

An evaluation of the commonalities across those events that had a significant direct effect on diagnosis would be useful for identifying the specific mechanisms through which these events affect the stress process and cause disease. The consistency in which these few events had an effect on disease (see Table 36) suggests that a major component that defines the individual response to events in the stress process has yet to be defined, assuming that the measures in the model adequately reflect the existing knowledge about the stress process.

There is a significant body of literature that suggests that the presence of a pre-existing condition has an effect on the occurrence and frequency of major life events, on the individual's ability to cope with the stressors, and on subsequent diagnoses. Although a measure of chronic disease was included in the analysis, an exploration of the impact of previously existing disease on the stress process was considered out of scope for the current analysis, and should be undertaken to determine if there is support for this argument. Clearly defining the relationship between chronic disease, the stress process and subsequent diagnosis would be useful to guide public health programs aimed at reducing co-morbidity and the development of disease.

The methodological decision to group diseases by category was necessary, given the complexity of the current analysis and the size of the sample, but evaluating the same model using individual diagnoses in a larger sample may provide more valuable information. The different impact of events and the measures of social and psychological resources on specific diseases compared to the chapter groupings (such as neoplasms and breast cancer, or endocrine system disorders and diabetes) suggests that the relationships may have been obscured by those methodological choices.

In addition, the method of analysis was intentionally very conservative, to ensure that a diagnosis of a disease could not predate the assessment of the individual's beliefs and perceptions of the stressfulness of the events, which may have underestimated the significance of the level of arousal or self-perceived stress in the model. Additional analysis using a longer follow-up period would provide a more complete picture of the development of health outcomes, and a more dynamic analysis using survival analysis techniques would enable the evaluation of the association between the predictors and the outcomes.

An analysis of the length of time between the measurement of the exogenous measures and the diagnosis of a health condition was considered to be out of the scope of the current analysis, due to time constraints in data collection. However, extending the timeframe in which health diagnoses are recorded could identify an important factor in determining the casual pathway and the significance of the mediating variables in the model. As this study is implemented in other communities in Alberta, the possibility exists to expand the analysis to include additional information about subsequent diagnoses further distant in time from the original collection period. One of the major limitations of the study was that the time period between the initial measurement of the exogenous variables and the diagnosis of a health condition was only one year. Because the lapsed time was so short, diagnoses had to be grouped into chapters. A longer lapse of time would result in more diagnoses, which would enable evaluation of the impact of the social and psychological measures on diagnoses at a more granular level. An analysis of the time lag between the experience of a stressful event and the subsequent diagnosis would be useful to determine the effect of the events and the stress response on diagnosis. Measuring the time elapsed between experiencing the stressful event and the diagnosis of disease would allow the coding of the diagnosis as a continuous variable instead of a dichotomous variable, which would improve the validity of the analysis. However, longer time delays between the measurement of events, the social and psychological measures and the disease outcomes impairs our ability to draw conclusions about causality. Conducting a longitudinal study with multiple measures of events and the social and psychological responses prior to development of disease would be necessary to adequately address these methodological issues.

Although the community wasn't significantly associated with diagnosis, the analysis would suggest that community was not an important factor in development of disease. However, it could be argued that the community in which the study was conducted played a significant role in the attitudes and coping behaviours of the respondents. Because the reference community was physically isolated and undergoing a period of extreme economic growth, different coping strategies may be at work compared to larger or less isolated communities - the effects of social marginalization in a small and physically isolated community may have a greater impact on health outcomes than social marginalization in a large community. Further evaluation of these associations in a larger less isolated sample would be useful to evaluate the impact of the specific factors associated with physical isolation.

Finally, the evidence of an association between self-perceived stress and a digestive system disorder is particularly important given the abandonment of this line of inquiry following the identification of H. pylori as the cause of stomach ulcers. This association was also identified by Suls, Wan and Blanchard (1994) in relation to irritable bowel syndrome. As mentioned above, the measure of self-perceived stress may in fact be indicative of a physiological change in the digestive system that popular nomenclature and custom informs the individual to interpret as stress, but which is, in fact, an early warning symptom of disease.

REFERENCES

Aneshensel, CS

1992 Social stress: Theory and research. *Annual Review of Sociology*, 18:15-38.

Averill JR.

1983 Studies on anger and aggression: Implications for theories of emotion. *American Psychologist*, 38(11):1145-60.

Avison, W.; Turner, R.J.

1988 Stressful life events and depressive symptoms: disaggregating the effects of acute stressors and chronic strains. *Journal Of Health and Social Behavior*, 29:253-264.

Bifulco, A; Bernazzani, O; Moran, PM; Ball, C

2000 Lifetime stressors and recurrent depression: preliminary findings of the Adult Life Phase Interview (ALPHI). *Social Psychiatry and Psychiatric Epidemiology*, 35:264-275.

Brisack NJ

2001 Stress, anger, and hostility: modifiable cardiovascular risk factors. *Journal of Practical Hygiene*. 10(1):32-3, 2001 Jan-Feb

Bradburn, NM

1969 *The Structure of Psychological Well-Being*. Chicago, Aldine.

Brown, GW; Harris, TO

1978 *Social Origins of Depression: A Study of Psychiatric Disorder in Women*. New York: Free Press.

Bush LE

1973 Individual differences: multidimensional scaling of adjectives denoting feelings. *Journal of Personality & Social Psychology*, 25(1):50-7.

Chang, P; Ford, D; Meoni, L; Wang, N; Klag, M

2002 Anger in Young Men and Subsequent Premature Cardiovascular Disease : The Precursors Study. *Archives of Internal Medicine*. 162(8):901-906.

Cohen, S

1980 After-effects of stress on human performance and social behavior: A review of research and theory. *Psychological Bulletin*, 88(1):82-108.

Cohen, S; Kessler, RD; Underwood Gordon, L

1997 *Measuring Stress: A Guide for Health and Social Scientists*. Oxford University Press: Toronto.

Cohen, S; Tyrell, DAJ; Smith, AP
2001 Psychological stress and susceptibility to the common cold. *Advances in Mind - Body Medicine*, 17(1):35.

Conte HR; Plutchik R
1981 A Circumplex Model for Interpersonality Traits. *Journal of Personality and Social Psychology*. 40:701-711.

Conway, T; Vickers, R; Ward, H; Rahe, R;
1981 Occupational stress and variation in cigarette, coffee, and alcohol consumption. *Journal of Health and Social Behavior*, 22:155-165.

DeLongis, A; Folkman, S; Lazarus, R;
1988 The impact of daily stress on health and mood: psychological and social resources as mediators. *Journal of Personality and Social Psychology*, 54(3):486-495.

Depue, RA; Monroe, SM;
1986 Conceptualization and measurement of human disorder in life stress research: The problem of chronic disturbance. *Psychological Bulletin*, 99, 36-51.

Desai, MM; Bruce, ML; Desai, RA; Druss, BG;
2001 Validity of Self-reported Cancer History: A comparison of Health Interview Data and Cancer Registry Records. *American Journal of Epidemiology, 153(3): 299-306.*

Dohrenwend, BP; Dohrenwend, BS;
1969 *Stressful Life Events: Their Nature and Effects*. New York: Wiley.

Dohrenwend, BS; Krasnoff, L; Askenasy, AR; Dohrenwend, BP;
1978 Exemplification of a method for scaling life events: the PERI life events scale. *Journal of Health and Social Behavior*, 19:205-229.

Ekman P; Levenson RW; Friesen WV;
1983 Autonomic nervous system activity distinguishes among emotions. *Science*, 221(4616):1208-10.

Ekman, G.
1955 Dimensions of Emotion. *Acta Psychologica*, 11:279-288.

Ensel, WM; Lin, N;
1991 The life stress paradigm and psychological distress. *Journal of Health and Social Behavior*, 32(4):321-341.

Eysenck, HJ;

2000 Personality as a risk factor in cancer and coronary heart disease in *Stress and Health*, Kenney, D; Carlson, J; McGuigan, FJ; Sheppard, J; (eds), Toronto: Harwood.

Fisher GA; Heise DR; Bohrnstedt GW; Lucke JF;

1985 Evidence for extending the circumplex model of personality trait language to self-reported moods. *Journal of Personality & Social Psychology*, 49(1):233-42.

Folkman, S & Lazarus, R

1988 Coping as a mediator of emotion. *Journal of Personality and Social Psychology*, 54(3):466-475.

Folkman, S.; Lazarus, R.; Dunkel-Schetter, C.; DeLongis, A.; Gruen, R.

1986 Dynamics of a stressful encounter: Cognitive appraisal, coping and encounter outcomes. *Journal of Personality and Social Psychology*, 50(5):992-1003.

Folkman, S.; Lazarus, R.; Gruen, R.; DeLongis, A.

1986 Appraisal, coping, health status, and psychological symptoms. *Journal of Personality and Social Psychology*, 50(3):571-579.

Folkman, S.; Lazarus, R.; Pimley, S.; Novacek, J.;

1987 Age differences in stress and coping processes. *Psychology and Aging*, 2(2):171-184.

Georges E.; Mueller WH.; Wear ML

1993 Body fat distribution in men and women of the Hispanic health and nutrition examination survey of the United States: associations with behavioural variables. *Annals of Human Biology*. 20(3):275-91.

Gillespie, M.W.

2001 Affect Balance and Total Affect Versus Positive and Negative Affect as Fundamental Measures of Emotional Experience: Simple Structure Is Not Always So Simple. Pp. 444-477 in A. Kaszniak (ed.) *Emotions Qualia and Consciousness*. Singapore: World Scientific Publishing Co.

Grimm, G.; Yarnold, PR (eds);

2002 *Reading and Understanding More Multivariate Statistics*. Washington, American Psychological Association.

Gruen, R.; Folkman, S.; Lazarus, R.;

1988 Centrality and individual differences in the meaning of daily hassles. *Journal of Personality*, 56(4): 743-763.

Health Surveillance;
2000 *Alberta Oil Sands Community Exposure and Health Effects Assessment Program: Technical Report.* Alberta Health and Wellness.

Heise DR;
1979 *Understanding Events: Affect and the Construction of Social Action.* New York: Cambridge University Press.

Hobfoll, SE; Schwarzer, R; Chon, KK;
1998 Disentangling the stress labyrinth: Interpreting the meaning of the term stress as it is studied in the health content. *Anxiety, Stress and Coping,* 11(3):181-213.

Holmes, T.; Rahe, R.;
1967 The social readjustment rating scale. *Journal of Psychosomatic Research,* 11:213-218.

Horwitz, AV; White, HR; Howell-White, S;
1996 The use of multiple outcomes in stress research: A case study of gender differences in responses to marital dissolution. *Journal of Health and Social Behavior*, 37(3):278-291.

Hoyle, RH
1995 *Structural Equation Modelling: Concepts, Issues and Applications.* Thousand Oaks: Sage Publications

Izard, C
1971 *The Face of Emotion.* New York, Appleton-Century-Crofts.

Jackson, PB; Finney, M
2002 Negative life events and psychological distress among young adults. *Social Psychology Quarterly.* Vol 65(2) Jun 2002, 186-201.

Jemmott, JB; Locke, SE
1984 Psychosocial factors , immunologic mediation and human susceptibility to infectious diseases: How much do we know? *Psychological Bulletin,* 95(1):78-108.

Kenny, D.; Carlson, J.; McGuigan, F.J.; Sheppard, J.
2000 *Stress and Health: Research and Clinical Applications*, Amsterdam, Harwood Academic.

Kessler, R.
1979(a)A strategy for studying differential vulnerability to the psychological consequences of stress. *Journal of Health and Social Behavior*, 20:100-108.

Kessler, R.

1979(b)Stress, social status, and psychological distress. *Journal of Health and Social Behavior*, 20:259-272.

Kessler, R.; Essex, M.

1982 Marital status and depression: the importance of coping resources. *Social Forces*, 61(2):484-507.

Kessler, R; McLeod, J

1984 Sex Differences in Vulnerability to Undesirable Life Events. *American Sociological Review.* 49:620-631.

Kline, R

1998 Principles and Practice of Structural Equation Modelling. New York: The Guildford Press.

Krause, N.

1987 Chronic Financial Strain, Social Support and Depressive Symptoms among Older Adults, *Psychology and Aging*, 2(2):185-192.

Lazarus, R; Folkman, S;

1986 Cognitive Theories of Stress and the issue of circularity, in *Dynamics of Stress: Physiological, psychological and social perspectives*, Appley, M; Trumbull, R; (eds), New York: Plenum Press.

Lazarus, RS;

2000 Evolution of a model of stress, coping and discrete emotions, in *Handbook of stress, coping and health: Implications for nursing research, theory and practice,* Rice, V; (ed) Thousand Oaks: Sage Publications.

Levenstein, S

1998 Stress and peptic ulcer: life beyond helicobacter. *British Medical Journal*, 316(7130):538-541.

Lorr M; McNair DM; Fisher SU

1982 Evidence for bipolar mood states. *Journal of Personality Assessment*, 46(4):432-6.

Lorr M; Wunderlich R

1988 Self-esteem and negative affect. *Journal of Clinical Psychology*, 44(1):36-9.

Lorr M; Wunderlich RA

1988 A semantic differential mood scale. *Journal of Clinical Psychology*, 44(1):33-6.

Lyon, BL

2000 Stress, coping and health: A conceptual overview, in *Handbook of stress, coping and health: Implications for nursing research, theory and practice*, Rice, V; (ed) Thousand Oaks: Sage Publications.

MacDonald, S. M., Reeder, B. A. Chen, Y., & Despres, J-P.

1997 Obesity in Canada: A descriptive analysis. *Canadian Medical Association Journal*, 157(Suppl. 1), 3-9.

Mattlin, J.; Wethington, E.; Kessler, R.

1990 Situational determinants of coping and coping effectiveness. *Journal of Health and Social Behavior*, 31:103-122.

McLeod, J.; Kessler, R.

1990 Socioeconomic status differences in vulnerability to undesirable life events. *Journal of Health and Social Behavior*, 31:162-172.

Melmed, RN.

2001 *Mind, Body and Medicine: An integrative text*. Toronto: Oxford University Press.

Miller MA.; Rahe RH.

1997 Life changes scaling for the 1990s. *Journal of Psychosomatic Research.* 43(3):279-92, 1997 September.

Miros, NJ.

2000 Depression, anger, and coping skills as predictors of suicidal ideation in young adults: Examination of the diathesis-stress-hopelessness theory. Dissertation Abstracts International: Section B: the Sciences & Engineering. Vol 61(6-B), Jan 2000

Mirowsky, J; Ross, CE

1995. Sex differences in distress: Real or artifact? *American Sociological Review*, 60(3):449-468.

Mohr, DC; Goodkin, DE; Bacchetti, P; Boudewyn, AC; Huang, L; Marrietta, P; Cheuk, W; Dee, B

2001 Psychological stress and the subsequent appearance of new brain lesions in MS. *Advances in Mind - Body Medicine,* 17(2):111-113.

Mooy, JM; DeVries, H; Grootenhuis, PA; Bouter, LM; Heine, RJ

2000 Major stressful life events in relation to prevalence of undetected type 2 diabetes. *Diabetes Care*, 23(2):197-202.

Morgan RL; Heise DR
1988. Structure of Emotions. *Social Psychology Quarterly*, 51(1):19-31.

Myhill, J; Lorr, M
1985 Comparisons of psychiatric outpatients with controls on bipolar profile of mood states. *Psychological Reports*, 56:779-782.

O'Malley, PG; Jones, DL; Feuerstein, IM; Taylor, AJ
2000 Lack of correlation between psychological factors and subclinical coronary artery disease. New England Journal of Medicine. Vol 343(18) Nov 2000.

Ortony A; Turner TJ
1990 What's basic about basic emotions? *Psychological Review*, 97(3):315-31.

Osgood, CE; Suci, GJ; Tannenbaum, PH
1957. *The measurement of meaning*. Urbana: University of Illinois Press.

Pearlin, L
1989 The Sociological Study of Stress. *Journal of Health and Social Behavior*, 30:241-256.

Pearlin, L; Schooler, C
1978 The Structure of Coping. *Journal of Health and Social Behavior*, 19:2-21.

Rahe, R
1975 Epidemiological studies of life change and illness. *International Journal of Psychiatry in Medicine*, 6(1/2):133-146.

Rahe, R
1988 Anxiety and physical illness. *Journal of Clinical Psychiatry*, 49(10):26-29.

Rahe, R; Ryman, D.; Ward, H
1980 Simplified scaling for life events. *Journal of Human Stress*, 6(4):22-27.

Raikkonen K. Matthews KA. Salomon K.
2003 Hostility predicts metabolic syndrome risk factors in children and adolescents, *Health Psychology*. 22(3):279-86, 2003 May

Ross, C; Mirowsky, J
1979 A comparison of life-event-weighting schemes: change, undesirability, and effect-proportional indices. *Journal of Health and Social Behavior*, 20:166-177.

Russell, JA

1980 A Circumplex Model of Affect. *Journal of Personality and Social Psychology*, 39:345-356.

Sable MR. Wilkinson DS.

2000 Impact of perceived stress, major life events and pregnancy attitudes on low birth weight. *Family Planning Perspectives*. 32(6):288-94, 2000 Nov-Dec.

Scott, B; Brandberg, M; Ohman, A

2001 Measuring the negative mood component of stress experiences: Description and psychometric properties of a short adjective checklist of stress responses. *Scandinavian Journal of Psychology*, 42:1-7.

Scully, JA; Tosi, H; Banning, K

2000 Life events checklists: Revisiting the social readjustment rating scale after 30 years. *Educational and Psychological Measurement*, 60(6):864-876.

Searle, A; Bennet, P

2001 Psychological factors and inflammatory bowel disease: A review of a decade of literature. *Psychology, Health and Medicine*, 6(2):121-136.

Seeman, M.; Anderson, C.

1983 Alienation and Alcohol: The Role of Work, Mastery, and Community in Drinking Behavior, *American Sociological Review*, 48:60-77.

Seeman, M; Seeman, T

1983 Health behavior and personal autonomy: a longitudinal study of the sense of control in illness. *Journal of Health and Social Behavior*, 24:144-160.

Selye, H

1956 *The stress of life*. McGraw-Hill, New York.

Selye, H

1975 Confusion and controversy in the stress field. *Journal of Human Stress*, 1:37.

Smith, C.; Haynes, K.; Lazarus, R.; Pope, L.

1993 In Search of the "Hot" cognitions: Attributions, Appraisals, and Their Relation to Emotion, *Journal of Personality and Social Psychology*, 65(5):916 -929.

Smith, D

2001 Negative emotions and coronary heart disease: Causally related or merely coexistent? A review. *Scandinavian Journal of Psychology*, 42:57-69.

Srole, L

1956 Social integration and certain corollaries. *American Sociological Review*, 21:709.

Steptoe, A; Cropley, M; Griffith, J; Kirschbaum, C

2000 Job strain and anger expression predict early morning elevations in salivary cortisol. *Psychosomatic Medicine*. Vol 62(2) Mar-Apr 2000, 286-292.

Stone, A; Broderick, JE

2001 Colds and the stress-illness connection: Cohen et al (1991). *Advances in Mind - Body Medicine*, 17(1):41-44.

Suls, J; Wan, CK; Blanchard, EB

1994 A Multilevel Data Analytic Approach For Evaluation of Relationships Between Daily Life Stressors and Symptomology: Patients With Irritable Bowel Syndrome. *Health Psychology*. 13(2):103-113.

Thoits, P

1982 Conceptual, Methodological, and Theoretical Problems in Studying Social Support as a Buffer against Life Stress. *Journal of Health and Social Behavior*, 23:145-159.

Thoits, P

1995 Stress, Coping and Social Support Processes: Where are we? What Next? *Journal of Health and Social Behavior*, (Extra Issue):53-79.

Travis, R.

1993 The MOS Alienation Scale: An alternative to Srole's Anomia Scale. *Social Indicators Research*. 28(1):71-91.

Turner, J

1999 Social Support and Coping, in *A handbook for the study of mental health: Social contexts, theories and systems*, Horwitz, A; Scheid, T; (Eds.) New York: Cambridge University Press.

Turner, RJ

1981 Social support as a contingency in psychological well-being. *Journal of Health and Social Behavior*, 22:357-367.

Turner, RJ

1972 The epidemiological study of schizophrenia: a current appraisal. *Journal of Health and Social Behavior*, 13:360-369.

Turner, RJ; Avison, W

1992 Innovations in the measurement of life stress: crisis theory and the significance of event resolution. *Journal Of Health and Social Behavior*, 33:36-50.

Turner, RJ; Gartrell, J

1978 Social factors in psychiatric outcome: toward the resolution of interpretive controversies. *American Sociological Review*, 43:368-382.

Turner, RJ; Lloyd, D

1995 Lifetime traumas and mental health: the significance of cumulative adversity. *Journal Of Health and Social Behavior*, 36:360-376.

Turner, RJ; Marino, F

1994 Social support and social structure: a descriptive epidemiology. *Journal Of Health and Social Behavior*, 35(193-212.

Turner, RJ; Wheaton, B; Lloyd, D

1995 The epidemiology of social stress. *American Sociological Review*, 60:104-125.

Turner, RJ; Lloyd, DA

1999 The stress process and the social distribution of depression. *Journal of Health and Social Behavior*, 40:374-404.

Turner, RJ; Roszell, P

1994 Psychosocial resources and the stress process, in *Stress and Mental* Health: Contemporary issues and prospects for the future, Avison, W; Gottlib, I (eds), New York: Plenum Press.

Venable, VL; Carlson, CR; Wilson, J.

2001 The role of anger and depression in recurrent headache. Headache. Vol 41(1) Jan 2001, 21-30.

Watson D; Tellegen A

1985 Toward a consensual structure of mood. Psychological Bulletin, 98(2):219-35.

Weinstein, J; Averill, J; Opton, E; Lazarus, R

1968 Defensive style and discrepancy between self-report and physiological indexes of stress. *Journal of Personality and Social* Psychology, 10(4):406-413.

Werner, J; Frost, M
2000 Major life stressors and health outcomes, in *Handbook of stress, coping and health: Implications for nursing research, theory and practice*, Rice, V; (ed) Thousand Oaks: Sage Publications.

Wethington, E; Kessler, R
1986 Perceived support, received support, and adjustment to stressful life events. *Journal of Health and Social Behavior*, 27:78-89.

Wheaton, B
1983 Stress, personal coping resources, and psychiatric symptoms: an investigation of interactive models. *Journal of Health and Social Behavior*, 24:208-229.

Wheaton, B
1985 Models for the stress-buffering functions of coping resources. *Journal of Health and Social Behavior*, 26:352-364.

Wheaton, B
1989 Life transitions, role histories, and mental health. *American Sociological Review*, 55:209-223.

Whitehead, W
1994 Assessing the Effects of Stress on Physical Symptoms. *Health Psychology*. 13(2):99-102.

Williams, J; Nieto, FJ; Sanford, C; Tyroler, HA
2001 Effects of an Angry Temperament on Coronary Heart Disease Risk. *American Journal of Epidemiology*, 154(3):230-235.

Williams JE. Nieto FJ. Sanford CP. Couper DJ. Tyroler HA.
2002 The association between trait anger and incident stroke risk: the Atherosclerosis Risk in Communities (ARIC) study. *Stroke*. 33(1):13-9, 2002 Jan

Zalaquett, CP; Wood, RJ
1997 *Evaluating Stress: A book of resources,* Volume 1, London: Scarecrow Press.

Zalaquett, CP; Wood, RJ
1998 *Evaluating Stress: A book of resources*, Volume 2, London: Scarecrow Press.

Zohar, D; Dayan, I

1999 Must coping options be severely limited during stressful events: Testing the interaction between primary and secondary appraisals. *Anxiety, Stress and Coping*, 12(2):191-217.